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THE CHALLENGE OF PEACE

IN his address last year at the Conference on Mineral Resources and the Atlantic Charter, arranged by the British Association, Sir Stafford Cripps struck a note that has been reflected more frequently in the speeches of American leaders than those in Great Britain. "We are fighting," he said, "for a moral and not merely for a material issue. Though our plans must be scientifically prepared there must be behind them the inspiration of our most deeply religious convictions." That note has been struck repeatedly in the speeches of Mr. Henry Wallace, of President Roosevelt and of Mr. J. G. Winant. It was clearly to be heard in the address broadcast by the Archbishop of Canterbury during the Day of National Prayer held on September 3 which marked the fourth anniversary of the outbreak of the War. Dr. Temple stressed the importance and urgency of preparedness for the tasks of peace, in themselves no less arduous than those imposed by war. The duties which will face us then, he said, will demand a spiritual approach.

The topic forms a main theme of Mr. H. Agar's recent book "A Time for Greatness", and in a different guise it is encountered in an article in the American periodical *Fortune*. That article touches simultaneously on a note that was very marked in the closing sessions of the House of Commons before the recess. The very success of the War in recent months and the growing conviction that victory was coming into sight had aroused concern as to our readiness to meet the problems of peace, a concern that was obviously fostered by the Government's refusal to take decisions and announce its policy on matters which in the Uthwatt Report, the Barlow Report or the Scott Report had long been before it. "The real danger to American civilization," wrote the editor of *Fortune*, "is a danger not of war but of peace. It is the danger that we may prove unable to make of peace a higher and more effective expression of that civilization than we have made of war. The danger is that we shall find no national purpose—except war—capable of evoking our greatest energies."

Conditions differ in the two democracies, but within the House of Commons and in the country at large there are many who would unhesitatingly subscribe to this new declaration of the need for a moral equivalent of war as being fully as pertinent to Great Britain as to the United States. The article sets fairly before the American reader the three great challenges to American civilization which challenge Britain no less: the threat of war to civilized life and the need to replace it by some such methods as implementing and making permanent the United Nations, an Anglo-American union, or the method of international law; the challenge of the machine and the solution of the problem of distribution which holds up the raising of standards of living throughout the world; and the philosophical challenge of the meaning of life—the rediscovery of faith.

These great postulates are challenges which know

no national frontiers. They reach to the foundations of our common civilization, and in meeting them out of the richest of their common experience and heritage, it may well be that Britain and America may find or renew a spiritual unity even closer than the physical unity which has brought them in sight of victory. Certainly such a spiritual unity affords the only enduring basis for whatever constitutional developments may flow from turning to the service of the needs of rehabilitation and reconstruction the agencies which we have had to bring into being for the effective service of the war effort.

While we may well welcome the evidence that Americans are being called by their own countrymen to fundamental thinking on the moral and vital issues which must be faced if they and we are to win the peace, there is no less need for fundamental thinking on this side of the Atlantic. Mr. Lionel Curtis's "Faith and Works" is an honest attempt to elucidate these issues from the British side, emphasizing the moral basis of any attempt to eliminate world war and the minimum constitutional changes which in his view would be sufficient for that purpose*.

Mr. Curtis takes up the position which Lord Lothian took up in his Burge Lecture in 1935, that the essential cause of world wars is the fragmentation of human society into more than sixty sovereign States. His basic point is that we should recognize that Great Britain standing alone is no longer able to ensure the security of the Commonwealth as a whole, or even that of the British Isles. It can no longer provide the security which the United Kingdom was able to provide in the nineteenth century when, as Prof. E. H. Carr observes, "the British fleet not only guaranteed immunity from major wars but policed the high seas and offered equal security to all".

There can be no doubt that Mr. Curtis is right in directing attention to this fundamental, if unpalatable, fact, though recognition of this and also of the truth of Washington's words, which he also quotes, "Influence is not government", does not necessarily lead to the view that the problem of security for the United Nations will only be solved when the peoples of the American and British Commonwealths have merged their resources under one organic government charged with their common defence. Mr. Curtis does not go all the way towards federalism, but his argument carries him far along the path towards the formulation of definite constitutional proposals as opposed to the functional growth which has been advocated by Prof. Mitrany in a recent paper issued by the Royal Institute of International Affairs. Mr. Curtis, however, forces us to face the fact that the Government of Great Britain will not be in a position to give again to the peoples of the occupied countries like Belgium, Holland and Norway such a guarantee as we gave to Belgium. We can only invite them to join in discussions as to how the burden of a common defence could be shared.

Proposals for the re-establishment of European and of world order and for the maintenance of peace must start from this point. Mr. Curtis's proposals are equally inspired by the belief that no duties should be entrusted to a central government which could be discharged effectively by a local or regional government, but that where duties are entrusted adequate power should also be provided. None the less, he strays a long way from the functionalism or the evolution and adaptation to the purposes of peace of the organisms set up to serve our war needs which now seems to be the main approach to the problem favoured by those actively concerned with the task of reconstruction.

Mr. Curtis insists that peace and social reform are two inseparable ends. Social reform and a higher standard of life cannot be achieved unless peace is firmly established among the nations; and we cannot establish peace unless national governments are really equipped to cope with social reform. His argument that the real obstacle to social reform is that national governments have so much to do that they cannot keep pace with the changes that a mechanized age demands, finds a pertinent illustration in the present impasse in Great Britain arising out of the Government's delay in implementing the decisions and policy called for in the field of physical reconstruction and planning. If it were possible to relieve national governments of the task of maintaining peace and to entrust it to an international government, the pace and efficiency of social reform might reasonably be expected to quicken.

Whether the line between international and national functions can be drawn as clearly as Mr. Curtis suggests is another matter; even in social reform, such matters as health and nutrition can scarcely be determined by independent national action alone. He would leave to the national governments the last word on the incidence of taxation between one citizen and another, on tariffs, on industry and commerce; international government would, however, be given power to make the security of all the nations it has to protect a first charge on all their resources, material and human; the burden of the revenue required for the common defence would be distributed between the nations defended in proportion to their taxable capacity as ascertained by a judicial committee of experts. Beyond this any international government charged with the task of averting war should have the power to hold under its own flag a merchant marine large enough to secure its transport needs in war, and such government should also be given complete control of all aviation between the nations united and charged with the duty of creating an adequate service. Finally, it must have power to control dependencies not ripe for responsible government.

As to the extent of the defence association, Mr. Curtis appears to have in mind one embracing Great Britain and one or more of the Dominions, the United States and the democracies of Western Europe. The international government should, he urges, be responsible, not to national governments but to the peoples they represent. Essentially he argues for an instrument selected and shaped for the particular purpose which it is to serve and free from commitments which might

* Faith and Works. By Lionel Curtis. Pp. vi+120. (London: Oxford University Press, 1943.) 2s. net.

dissipate its energies or confuse the issues. He insists that we should not treat instruments and methods as ends in themselves and lose sight of the ends for which they were devised.

The insistence on moral values and the note of pragmatism which is sounded throughout give Mr. Curtis's pamphlet a real value in discussions on the form which the organization of world government must take. Whether we accept his conclusions or not, he emphasizes some of the realities which must be faced in any solution, and different as are the conclusions he draws from those drawn by Sir Frederick Maurice in his recent study of "The Armistices of 1918" they are a striking complement to the latter. In both, indeed, there is the same note of urgency—Sir Frederick Maurice's first point is that a request for an armistice may come as unexpectedly as any event in war—and both insist on the need for foresight and preparation and the necessity of maintaining for an indefinite period the power to enforce the will of the United Nations, or in other words to maintain the peace.

Sir Frederick Maurice points out that the preparation necessary if the terms of armistice are to be satisfactory should include arrangements for the effective occupation of enemy territory until satisfactory terms of peace are assured; and, as corollary to his second conclusion as to the maintenance of effective military force, he points out that it is important that an early decision should be reached as to the size and distribution of the forces which the Allies should maintain. A programme should be prepared for the gradual reduction of our forces and announced to the Services at the earliest possible date, and no political or private interests should be allowed to interfere with the orderly execution of this programme.

It may well be asked whether such a programme can be drawn up except on the basis of such discussions as are envisaged by Mr. Curtis. The fatal mistake of unilateral disarmament must not be repeated, and the indispensable measure of agreement on this point between Great Britain, the United States and the U.S.S.R., if not with others of the United Nations, might well be the prelude to some such organization as Mr. Curtis suggests, though probably less formal, and based on governments, not on the individual citizens. Sir Frederick Maurice's third conclusion, that the preparation of terms of armistice, the supervision of the execution of these terms, and the solution of the many and varied problems which will arise after the signature of the armistice raise questions different in nature and kind from those which are brought up by the preparation of treaties of peace, again emphasizes the necessity for formulating plans and reaching agreement on peace aims in advance. Preliminary studies must be made during the War and a nucleus of the necessary organization established.

His final conclusion that the Allies, if they are to secure their declared war aims of disarming the aggressors, must provide themselves with the necessary means, once again emphasizes the necessity not only for adequate force but also for agreement as to its constitution. Here he suggests that air power may provide a solution, and that it should be our object to deprive our enemies of all aircraft, military or civil, and to control their disarmament by an allied air force until such time as more permanent arrangements for the prevention of aggression can be established. He sees in the trial of such an air force composed of contingents of the air forces of the Powers, members of the international authority, to control our enemies in the interval between the signatures of armistices and the ratification of treaties of peace an opportunity to experiment which if successful could be made part of a permanent organization for the preservation of the peace of the world.

There may well be less difference than appears on the surface, therefore, between the proposals of Mr. Curtis and the conclusions reached by Sir Frederick Maurice. The latter is strikingly in line with pronouncements which have already been made by members of the Government in both Great Britain and the United States. In his important Guildhall speech last February Mr. Herbert Morrison contemplated the creation in due time of a genuinely representative world political association. Like all others he emphasized the necessity of any such association possessing a force fully sufficient to achieve its agreed purposes and to restrain those who would impede them, but he spoke also of how constructive and systematic thought on the problems of supply and raw material allocation, of relief and rehabilitation was creating the very stuff and content of post-war international relations. On the American side, Mr. Cordell Hull has been equally explicit as to the necessity for creating some international agency. Again, the American Commission to Study the Organisation of Peace has both recognized the spiritual and ethical basis on which any form of world organization must rest and stressed the necessity for new institutions, world-wide and regional, to perform services which can no longer be left to each State acting as a separate unit.

One well-marked school of thought looks to the development of Europe's public utilities to encourage a fuller sense of Continental unity. Mr. Amery, rejecting the idea of federation for the British Empire, although contemplating some regional or federal developments into larger units by the smaller countries of Europe, looks to closer working arrangements between Britain and the Dominions and the development of the Imperial Conference system. It will not escape notice that Mr. Churchill paused very deliberately for consultations in Quebec before proceeding to the United States on his latest visit to America. If we are to exclude federalism, on defence grounds alone the facts emphasized by Mr. Curtis will compel us to establish some working executive of defence which can scarcely be limited to the Empire, and it will be at least essential for all the British nations to be ready to take commitments in common council.

One suggestion, advanced by Sir Edward Grigg, is for a series of Empire regional councils, but more than this will clearly be required however much

such a development might assist us to surmount some of the geographical difficulties. Meanwhile, Mr. Richard Law has hailed the Hot Springs Conference on Food and Agriculture, with its establishment of an interim Commission to carry on its work, as the birth of the United Nations. The United Nations Relief and Rehabilitation Administration is another notable step in the same direction, and in the Combined Raw Materials Board, the Combined Food Board and the Shipping Adjustment Board we have other instruments which may serve as a basis for world co-operation after the War. More is, of course, required. Currency plans are as yet embryonic, and only the most tentative approach has been made to the vast problems of international trade and exchange; and there are no signs at all that anything of the nature of a general staff for peace has yet been set to work in accordance with the important suggestions made last year by the Netherlands Ministers for Economic Affairs and for Colonies.

The arguments advanced by Mr. Kerstens and by Dr. van Mook have lost nothing in weight since last autumn, and though it is clear from Mr. Churchill's broadcast last March that the Government is thinking about these problems in general terms the time is fast approaching when some more definite assurance may well be demanded that the Government is ready not only with the armistice plans discussed by Sir Maurice Hankey but also with concrete proposals for dealing with the grave problems of order and reconstruction which must be handled before any permanent form of world association is possible. The vital thought and study in these matters are required now if we are to be ready in time, and no pre-occupation with the conduct of the war can justify postponement of the facing of these tasks, more difficult and more arduous than any the leaders of the United Nations have yet encountered. Whether they prove equal to those searching demands, whether they can provide the leadership which will find and secure acceptance of a solution of these difficult problems of world order depends on whether they bring to their task not only the realism and vision on which Mr. Curtis insists, but whether also they have the imagination to take their peoples into their confidence and to make them understand the conditions and the sacrifices involved, so that neither peoples nor leaders shall again be guilty of the moral slackness and indulgence that, as Sir Geoffrey Knox has just pointed out, played so large a part in robbing us of the fruits of victory after the War of 1914–18 was concluded.

Unless both leaders and peoples alike have the courage to face the full facts and the resolution not merely to shape the appropriate instruments but to use them with imagination and discipline, our hopes of a better world order and an enduring peace are vain indeed. For whether that world order comes by evolution or by revolution in the physical world, it may well involve a moral revolution, for it is based on men and women and human values: courage, unselfishness, and magnanimity, firmness of purpose and clarity of vision, truth and honesty—these are the ultimate foundation.

SCIENCE, RELIGION AND EDUCATION

Science, Religion and the Future

A Course of Eight Lectures. By the Rev. Charles E. Raven. Pp. x+126. (Cambridge: At the University Press, 1943.) 7*s*. 6*d*. net.

Education in World Ethics and Science

Conway Memorial Lecture delivered at Conway Hall, Red Lion Square, W.C.1, on March 28, 1943. By Sir Richard Gregory. Pp. viii+40. (London: Watts and Co., Ltd., 1943.) Cloth, 2*s*. net; paper, 1*s*. net.

Discipline for Democracy

By T. V. Smith. (Weil Lectures on American Citizenship.) Pp. xiv+137. (Chapel Hill, N.C.: University of North Carolina Press; London: Oxford University Press, 1942.) 12*s*. net.

THE "conflict between religion and science", to quote from the title of J. W. Draper's book published in 1874, which was widely read sixty years ago, means practically for most of us the battle between believers in the Biblical accounts of creation and believers in the theory of evolution. That contest has abated its intensity, but there is evidence that it still exists, though in milder forms, in places much nearer than Tennessee. This is the point of departure chosen by Dr. C. E. Raven, regius professor of divinity in the University of Cambridge, in a vigorously written book which has recently appeared. Insisting on the necessity of outspokenness, he declares that "while the Christian religion as professed by the churches still clings restrictively to a *Weltanschauung* that is demonstrably unscientific, to superstitions that violate the intelligence and to conduct that shocks the morality of modern man, no such consistency as is essential can be expected. To be a Christian, or at least to hold official position in the churches, is to accept formulæ parts of which can only be explained by being explained away, or else to keep secular knowledge and religious belief in permanent estrangement". Dr. Raven gives a characteristically lively account of the conflict which began on June 30, 1860, with the encounter of Huxley and Wilberforce at the Oxford meeting of the British Association, and which "made overt and abiding the cleavage between traditional Christianity and progressive science".

The author's main concern, however, is not with the conflict as a historical fact, but with what he holds to be "its tragic consequences in the bewilderment, corruption and destruction of mankind". For, says he, "the outbreak of the struggle in 1939, though it plainly demonstrated the need and the opportunity for the assertion of an integrating, and, as many recognized, authentically Christian ideal, found the Church theologically and ethically divided and in consequence practically impotent". So it was left to "the bright superficiality of the Brains Trust to supply the public with answers to its problems and guidance in its search for a philosophy of life". The remedy, for which the author puts in a powerful plea, is the unflinching application of the scientific method to every human interest. It is largely, he says, the acceptance of psychology as a science, complementary as this acceptance is to the stress upon the subjective and relative elements in the new physics, that "has led the younger men to claim all organized knowledge as the scientist's

proper province, and to consider how methods can be developed for the scientific study of ranges of experience not amenable to the technique appropriate to material objects in a laboratory". The scientific method is not the sole perquisite of workers in laboratories, but may be applied "as rigidly and honestly in their proper fields by historians and even theologians". Needless to say, the author strongly dissents from the position that scientific method necessarily involves measurement. Throughout the book the author obviously tells the reader exactly what he thinks, with a minimum of care for official discretion. He writes not only as a distinguished theologian, but also as an ardent field naturalist.

All things considered, one need not wonder at finding points of contact between Dr. Raven's lectures and Sir Richard Gregory's Conway Memorial Lecture delivered last March. It is perhaps permissible to say that the former writes as a scientific humanist and the latter as a humanistic scientist, and that between the two there is no yawning gulf. Sir Richard, for example, recalls incidentally the story of Joshua's treatment of Jericho, remarking that Hitler is doing the same to-day on a vastly larger scale. "Such, however," he proceeds, "is the reverence attached to Holy Scripture that in a 'Lift up your Hearts' talk with which a B.B.C. clergyman opened the day a short time ago, he told the story as an example of a warrior following a Divine command! This is a kind of religious teaching against which both heart and reason revolt." Sir Richard's general position is that while science cannot deny the fact of religion or the influence of religious faith, it may examine them and seek to understand them. "With increase of knowledge, much of the mystery upon which religious beliefs are based is revealed and new concepts have to be created to satisfy the rational mind. It is when there is a refusal to recognise this essential function of progressive knowledge that conflict arises between religion and science." He reasonably claims that the changes associated with the meaning of modern civilization are results of scientific discovery and mechanical invention, and that progress in these has never been encouraged by religious teaching. He has no quarrel with religious teaching, including Christian teaching, except when it is intolerant, and he regards it as intolerant when it ignores or even denies the virtues of other great religions, adherents of which are at this moment fighting on our side for a certain way of life upon which they place an equal value.

The remaining book of those here selected for notice is also the permanent record of a lecture, one of the Weil Lectures on American Citizenship given at the University of North Carolina. The author, who writes with equal charm and candour, is Prof. T. Vernor Smith, of the University of Chicago. As eternal vigilance is the price of liberty, so, says the author in effect, is strict discipline the price of democracy. He makes very clear what we are fighting for. What a burden is laid upon the spirits of free men, he cries, to have to do evil that good may possibly be restored! "For the whole world to sink as low in spiritual tone as Naziism has sunk would be to lose next to all that civilisation has gained. It would be to lose truth to its boasted subversion, a propaganda diabolically intent upon prostituting goodness and beauty no less than truth to the poison of power." Keeping the three absolute values in view, he proceeds to deal with science as the discipline of truth, art as the discipline of beauty, and (strange as it may sound at first) politics as the discipline of goodness. Such is the discipline to which democracy must strive to submit.

Democracy is unworkable except by "agreement among equally able and equally honest seekers after truth"; and, says the author in a significant passage, the simple fact is that religion has no method of resolving differences and of begetting agreement. For that reason he rejoices at "the wise separation of Church and State" in the United States. Toleration is the only solution of the differences between Methodists and Baptists. For reasons that lie in history, Unitarianism is more important in New England than in Old England, and the author quotes the witty remark that Unitarianism proclaims "the fatherhood of God, the brotherhood of man, and the neighbourhood of Boston". Generalize that saying, and you have the reason why religion can never be a reconciler of differences. Science, not religion, provides "the strategy of agreement". Some citizens (men of science) "indulge" in it and enjoy its roots, more citizens (teachers and the like) "participate in it and smell its sweet flowers", and all citizens are beneficiaries of it and enjoy its fruits. Thus far science, with its disinterested and relentless pursuit of truth. The searchers are few, but the beneficiaries are all mankind.

Yet the author departs from the hard counsel of W. K. Clifford, that it is wrong "always, everywhere, and for every one, to believe anything on insufficient evidence". Truth is not the only value which defines civilization. Civilization would be infinitely poorer if it were so—witness the classical instance of Charles Darwin, who lived to lose all his early interest in poetry, pictures, and music. Science contracts the life of imagination. Art expands it, up to the acceptance of all which the mind's eye can discern. Again we have the citizens (artists) who indulge in art and enjoy its roots, more (parents and teachers and trainers) who participate in it and smell its sweet flowers, and all citizens who are beneficiaries and enjoy the fruits so vividly described by the author.

What of politics, as the discipline of goodness? Reduced to simple terms, politics are just the art or the science of settling disputes. Domination is the only alternative when equally honest men are in deep difference as to what is good. Either one side gets its complete way—which is dictatorship—or a new way is devised in which each gets enough of what it wants to observe a truce in the spirit of sportsmanship—which is democracy. Here the author gives a shining example of political compromise at work. The American Union is a system of two incommensurable but not incompatible principles, the principle of compromise for the settlement of all weighty disputes, and the principle of no compromise for the protection of all private principles compatible with public order—such as religious principles. The author will not allow the finger of scorn to be pointed at the politician, and he shows that all citizens of a democracy enjoy more fruits than they themselves create.

The functions of science, art and ethics in a well-ordered democracy, and incidentally the treatment of religious and other private convictions, are trenchantly discussed in this remarkable book. The author should become better known in Great Britain.

T. RAYMONT.

JOHN GILBERT: ORNITHOLOGIST

Strange New World

The Adventures of John Gilbert and Ludwig Leichhardt. By Alec H. Chisholm. Pp. xxii+382+25 plates. (Sydney and London: Angus and Robertson, Ltd., 1941.) 12s. 6d.

THIS book tells of two journeys of discovery, the one free of hazard and successful beyond expectation: the other always on the brink of disaster, ending in stark tragedy. The first adventure is that undertaken in 1938 by Alec Chisholm in search of personal relics of John Gilbert, the second is that of Ludwig Leichhardt, who in 1844 set off over the Darling Downs to reach Port Essington. The name of John Gould "the Bird Man" is known all over Australia in association with the wonderful bird fauna of Australasia. John Gould is a substantial figure whose achievements are amply chronicled in the "Dictionary of National Biography" and other works of reference. John Gilbert, though almost equally well known as a name in Australia, was, until Chisholm's voyage of discovery ended in triumph, no more than a name to anyone, for next to nothing was known of the man himself. How Chisholm finally discovered Gilbert's note-books and diaries in the possession of Drs. Geoffrey and Alan Edelsten, grandsons of John Gould's eldest daughter Eliza, is a story of happy achievement. John Gilbert has at least become a real individual whose doings in Australia and even whose intimate thoughts are revealed in his note-books; and if his birthplace, his youth and his life before his association with Gould are probably destined to remain unknown, we are happy that the man, now the curtain has been partly drawn aside, is seen as something bigger than a mere intelligent field collector whose labours made it possible for the wonderful son of a gardener to publish the "Birds of Australia".

But Gilbert's diaries do more than this, for he was foolish enough to become one of the misguided band that placed itself under the leadership of Leichhardt, whose ill-considered overland expedition from "Jimba" (north of Brisbane) to Port Essington (north of Port Darwin) set out in September 1844. During this trying journey, until his death at the hands of the natives on June 28, 1845, John Gilbert, though loyally supporting the leader of the expedition in every possible way, could not refrain from noting, in the intimacy of his diary, the character and the actions of the man who was responsible for the enterprise. These notes made by Gilbert amply confirm those estimates of Leichhardt's character afterwards made by Bunce, Mann and others who were associated with him in his later enterprises. Gilbert's diary throws much light on this unsatisfactory and overrated man, and it is time that the tradition of Leichhardt's greatness be permitted to pass into oblivion.

The real facts concerning Friedrich Wilhelm Ludwig Leichhardt seem to be that, after an obscure boyhood on the farm of his parents in Prussia, he became an unsatisfactory student at Göttingen and Berlin. Infirm of purpose in all things save in a determination to avoid work, he indulged in introspection and became absorbed in overwhelming self-pity. He drifted. It seems certain he never pursued any study to the length of taking a degree. His Australian assumption of the title "Dr." and his claim to be a medical man appear to have been merely indications of vanity, and his treatment of the sick men under his care belies any possibility of a medical training. Unwilling to make any effort to earn his own living, he became parasitic on friends and fixed his tentacles firmly into a worthy English fellow student named William Nicholson. Nicholson brought him to England and later, apparently as the only way of being rid of the incubus, gave him money and paid passage for him to Australia. In his new environment, he again became parasitic on friends and made no effort to find occupation until, financed and equipped at the expense of others, he started on the enterprise for which he had no sort of qualification either of leadership or of attainment. Briefly, he proved disloyal to the men who risked their lives with him, he was callous to the sick men in his charge to the length that he stole their rations when they were no longer able to claim them. He was cruel to animals, on the proper care of which his success so largely depended. Even in a camp of rough men living in rough times and under great disadvantages his personal habits, evinced in his total disregard of hygiene and disgustingly coarse dietetic tastes, proved revolting. These personal characteristics rendered him unfitted to lead; but unfortunately for the men who placed themselves under his leadership, he was devoid of any real knowledge of bush craft and was incapable of taking an accurate observation to determine his whereabouts. On one occasion Gilbert notes that the party had struck a valley which, since they felt sea breezes, they thought would open out into the Gulf of Carpentaria. As a matter of fact, the expedition was not within a thousand miles of the Gulf and the sea breezes came from the east coast near the site of the present town of Rockhampton.

Perhaps a more remarkable circumstance revealed by Gilbert's diary is the fact that within the first four months of the expedition, nine out of the ten members of the party had been hopelessly lost in the bush at some time or other and that the leader had had this unfortunate experience on more than one occasion. To be completely lost in the bush is a terrible experience for any man, but for Leichhardt it was especially dangerous since, as he was unable to use a gun, he was quite incapable of obtaining food. The odd thing is that these experiences never seemed to diminish the man's vanity or to make him any more cautious or responsible; and so Gilbert's story goes on up to the tragic night when he received his fatal spear wound and the diary ceased abruptly.

Even of this incident Leichhardt refrains from telling the truth, which was, however, suspected by Gilbert and told in his diary the day before his death. Leichhardt told the world that the attack of the natives was entirely unprovoked. Gilbert suspected, and Leichhardt knew quite well, that the attack was an act of retaliation by the natives for brutal interference with their women by Brown and Charlie, the aboriginal members of the party.

Here, with the death of Gilbert, we may leave Leichhardt. Had he never undertaken his last ill-conditioned enterprise and with his unfortunate fellows, his circus of horses, mules, cattle, goats, sheep and dogs, vanished completely and for ever, he would probably have been assessed at his true worth and not have become a legendary hero in Australia. As for John Gilbert, all ornithologists are in debt to Chisholm for giving us even a partial picture of a man who, under the worst possible conditions, patiently fulfilled his mission of collecting the

Australian fauna, to the gain of science. Nor was Gilbert a mere collector. It was surely a remarkable thing that, even when short of food, clothing and every other necessity and at the end of a day of hardships, he would sit down and write several thousand words on the habits of birds and beasts observed during the day. To those who have experienced even a minor degree of such conditions it must appear still more remarkable that he wrote all his notes neatly with pen and ink. He had the true spirit of science, and Chisholm is to be thanked for letting us know more about John Gilbert the naturalist as distinct from John Gilbert the man who collected for Gould.

The reviewer has only one regret after reading this valuable addition to our knowledge of birds and men in the early days of Australia. Surely the title—"Strange New World"—is a trivial and even misleading one under which to launch so important a contribution to biography. F. WOOD JONES.

OBITER DICTA OF A SOCIOLOGIST

Diagnosis of Our Time

Wartime Essays of a Sociologist. By Karl Mannheim. (International Library of Sociology and Social Reconstruction.) Pp. xi+179. (London: Kegan Paul and Co., Ltd., 1943.) 10*s.* 6*d.* net.

PROF. MANNHEIM has achieved a position of deserved distinction among sociologists as the author of "Ideology and Utopia". In the present volume he gathers together a number of his addresses delivered to audiences as diverse as the staff members of the University of Durham and the listeners-in of the B.B.C. overseas broadcasts.

In his addresses on education he shows an approach that is in many ways typically Continental and which, in my experience, shows itself whenever the representatives of European universities, secular or Catholic in type, meet representatives of the universities of the English-speaking world. Values are known, Prof. Mannheim feels, and the educator must teach them. In the English-speaking world there is a persistent (and to my mind valuable) prejudice to the effect that truth has to be groped for and that, when 'values are taught' dogmatically, this generally ends by meaning that the schools will teach whatever particular set of values the government and politicians of the day find convenient—whether it be the commandment of the Decalogue "Thou shalt not kill" or conversely the maxim *dulce et decorum est pro patria occidere*. Either way the pure light of disinterested inquiry is smoked.

Prof. Mannheim, however, performs a very valuable service in raising this issue of values, even if his language occasionally seems too guarded and discreet and as if he had the sense of being a guest. Mr. Lewis Mumford and Dr. Archibald MacLeish have raised this issue in the United States and, in a very different but more profound sense, Mr. Herbert Read has done so in Great Britain, as have various theological writers such as Niebuhr and Berdyaev. Prof. Mannheim has my sympathy in endeavouring, unlike the last-named, to state his values in humanistic terms. Like Dr. Peter Drucker he is concerned with what he calls "planning for freedom", and the type of civilization of which he approves, neither National Socialist nor National Communist, fits into this framework. He rightly insists that although we can perhaps teach mathematics, we cannot teach, for example, history, without a sense of social values (which does not mean that it is futile to try to teach history or political science 'objectively'). If this sense is not permitted explicit expression, then, as with the village atheist teaching in the village church school, it finds expression covertly. We have to decide whether we approve of the current worship of 'dynamism' and of what Dr. Mannheim calls "the demoniac image" (by some others called "the heroic image") "of man emphasizing power and the military virtues of discipline", etc. I am frank to say that I myself, holding very strongly views which I imagine are those of Prof. Mannheim, would yet like to see senior schools in which both views—the dynamic-heroic (or demoniac) and the religious-quietist—were taught. I agree with Plato—and I suspect disagree with Prof. Mannheim—in believing that the human race is not monotonous and all cut out of one cloth, but functional—some natural economic Marxists, some natural Fascists or pro-Fascists (such people, for example, as some of our most vocal patriots and contemplatives, bomber-leaders), and some natural or rulers (spiritually or techno-oratically speaking). The real problem of values is to give to each of these attitudes due weight and no more than due weight.

Prof. Mannheim obviously distrusts the Marxist basically economic interpretation of history; is concerned about the excesses of an industrial civilization; touches on that question of neighbour relations now preoccupying the mind of MacMurray, Heard and others under the name of 'community' (incidentally resurrecting the good Prof. Cooley). He assumes, unlike Prof. Laski, "fundamental agreement on the method of experiment" in our democracy. He aspires to develop a philosophy of 'the middle way' between *laisser faire* and totalitarianism. I myself, having sought precisely such a middle way in my "Preface to Action", and found it, as between Germany and the U.S.S.R., as the Anglo-Saxon philosophy of experiment, or what Dr. Fromm calls 'spontaneity', am now inclined to the more pessimistic belief that a rhythm occurs in history between the extremes, and that the only remedy for the extremity of the extreme is to be found in a humanistic scepticism about what can be achieved in the formally political or governmental sphere. What matters are the outlooks of societies rather than the forms of government. What really matters is the conformity of local institutions to the simple human intuitions, and not this plan or that plan as a creed or as more than an empiric instrument to be discarded at convenience. There can be a 'planned freedom' for a steel worker in need of employment and sport; I do not see how there can be a planned freedom, in any profound sense, for an artist of vision. He will have to find his own 'like-minded society'. Freedom, in the last resort, is not a political matter (despite Prof. Mannheim's antithesis of individual and society, meaning society-under-government) but a spiritual matter. However, that what is here called "value standardization" is not only possible in small communities but also can be successful in large is shown by the example of China. I put down this book with the feeling that I should like to see many of its central ideas further developed, and with a desire to be present at a debate between Dr. Mannheim and Dr. Niebuhr. I should be an impartial arbiter.

GEORGE CATLIN.

APPEARANCE OF GLUTATHIONE DURING THE EARLY STAGES OF THE GERMINATION OF SEEDS

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TWO interesting papers have been published containing studies of the phenomena with which the present research is concerned. Firket and Comhaire[1] state that while absent in the dry pea, glutathione, or at least –SH compounds, rapidly appear after these are placed under water. These sulphydryl compounds are distributed throughout the cotyledons, seeming to prepare the conditions for the growth of the embryo rather than being produced under its influence. After reaching a maximum they diminish during the growth of the embryo, more slowly when growth proceeds in the dark. Vivario and Lecloux[2] confirm the early appearance of glutathione during hydration. It reaches a maximum after 4–6 hr.; this increase is more rapid at 38°. The authors found that formation is quicker in powdered peas owing to the more rapid uptake of water.

The facts revealed by the above authors are of much interest but the numerical data they present require revision. In each case it was, of course, realized that other reducing substances besides thiol groups might be present. They therefore carried out two titrations with iodine, one with nitroprusside as indicator and the other with starch. The latter gave somewhat higher figures than the former, and the difference was assumed to be due to other reducing substances. It is now known, however, that the use of nitroprusside as an indicator gives unreliable results. Moreover, these results were calculated as glutathione when this was still supposed to be a dipeptide. In any event, although with animal tissues it is usually safe to assume that no other thiol compounds need to be considered, this assumption was not justified in the case of germinating seeds, where protein changes are so active. Free cysteine might well be present, and, indeed, we have found this to be the case.

We have ourselves succeeded in isolating glutathione from germinating peas by methods which will be described.

Experimental

The early appearance of –SH groups during germination is clearly general among plants, and appears universal. On qualitative lines we have proved their presence in the seeds of the following: Gramineæ (endosperm): rye, barley, wheat, maize; Leguminosæ (cotyledons): sanfoin, vetch; Cruciferæ (cotyledons): cabbage, mustard, wallflower; Chenopodiaceæ (endosperm): spinach; Caryophyllaceæ (perisperm): silene.

In each case, 5 gm. was extracted with trichloroacetic acid, the extract saturated with ammonium sulphate and centrifuged, and to the solution one drop of 5 per cent nitroprusside and then ammonia were added. This was usually on about the second or third day of germination. A positive reaction was always obtained varying somewhat in intensity, the strongest being in the Leguminosæ and the weakest in the Gramineæ. Kozlowski[3] obtained qualitative reactions for –SH in a variety of seeds. He also found that the Leguminosæ gave the strongest reaction.

Isolation of Glutathione. We found greater difficulty in this task than is offered in the case of yeast and animal tissues. Our first attempts, however, were made on lines that have been customary, but these early experiences may be very briefly described. We worked chiefly with different strains of the garden pea, and we used trichloroacetic acid as an extractive. Such extracts have the fundamental fault that, in them, all metallic precipitants produce precipitates which are apt to be colloidal in character. We tried cadmium acetate but found that this gave so bulky a precipitate that it could have little selective value. We therefore used the familiar mercuric sulphate reagent. Its precipitates tend to be colloidal, but with careful adjustment of *p*H we found we could centrifuge and wash them, though at each stage with some loss.

In one experiment 3 kgm. of peas, on the fifth day of germination, was ground up in trichloroacetic acid by use of sand in a mechanical pestle and mortar. In the extract, after some preliminary treatment, we used mercuric sulphate as a fractional precipitant, and from the three fractions, after the usual treatment, we obtained three separate products. Of these only one (the most soluble) yielded the typical copper compound of glutathione on adding cuprous oxide to its solution in 0·5 *N* sulphuric acid. The product obtained from this acted characteristically as a coagent to glyoxalase activity. Moreover, when heated in aqueous solution, it gave, after evaporation on the open water bath, typical crystals of the diketopiperazine of cysteinyl-glycine. The product evidently contained a large proportion of glutathione, but its melting point was low, and it gave analytical data which showed it to be impure. It is noteworthy that the other two of the three products referred to, after oxidation, showed typical hexagonal crystals of cystine.

Trichloroacetic acid is clearly not very satisfactory for the extraction of plant tissues. Moreover, at this time it became difficult for us to work on a large scale. We therefore worked out another process applicable to relatively small quantities of material; this gave satisfactory results. The seeds are first ground up by hand in a mortar with 0·1 *N* sulphuric acid and a little washed sand, the extract centrifuged and the solution half saturated with solid ammonium sulphate. The filtrate from the precipitate thus produced (350 ml.) is brought to 0·5 *N* sulphuric acid. To this, cuprous oxide is added in small quantities with frequent stirring. It is remarkable that no precipitate appears at once, but after standing for twenty-four hours a quite typical precipitate of the copper compound separates. It would seem that some unstable association between the cuprous compound and the ammonium sulphate is first formed (? a co-ordination compound) which slowly decomposes. These facts apply no less to pure glutathione.

The only drawback to this simple procedure is that, owing to the delay in the separation, it is difficult to estimate with exactness the amount of cuprous oxide which is necessary. Slight excess is added, and after standing for twenty-four hours in an open beaker, the precipitate, which may be mixed with a small amount of copper oxide, is centrifuged off and the fluid allowed to stand for a further twenty-four hours. If more of the copper compound separates, this is centrifuged off and added to the first precipitate. After forty-eight hours no further precipitate has ever been observed.

Preparations 1 *and* 1*a.* 10 gm. of peas was soaked

for twenty-four hours in water and then treated as above. The crystalline copper precipitate, after washing free from sulphate, was decomposed as usual, and the filtrate from the sulphide freed from hydrogen sulphide by a stream of hydrogen. One half was evaporated to dryness in a vacuum desiccator and weighed 25·5 mgm. (51·0 mgm. per cent). This residue titrated with 0·01 *N* iodine used 7·3 ml., equal to 22·41 mgm. (44·82 mgm. per cent) of glutathione. A quantitative estimation was made by Woodward's manometric method[4]. For the latter a four-point reference curve was first obtained to establish accurate relations between the tripeptide and the carbon dioxide measured. The glyoxalase was made from rats' red corpuscles on the lines described by Jowett and Quastel[5]. The amount of the solution used for the estimation contained 0·127 mgm. of the preparation, and the amount of carbon dioxide evolved in 20 min. (99·54 µl.) was equivalent to 23·0 mgm. (46·0 mgm. per cent) of glutathione. As in this experiment the whole solution was taken directly to dryness and not crystallized out from a mother liquor, it will be understood that the slight excess in the weight of the residue might be due to a trace of impurity. But it would seem that the product was practically pure.

100 gm. of the peas, after soaking for twenty-four hours in water, was transferred to a funnel (which permits of an adequate oxygen supply) and allowed to germinate for three days. The peas were then treated as above. The total residue of the final product was 14·6 mgm. per cent, by iodine 11·05 mgm. per cent, and by Woodward's method 11·0 mgm. per cent. These results confirm the statements of Firket and Comhaire[1], also those of Vivario and Lecloux[3], that the sulphydryl groups diminish once actual growth is established.

Preparation 2. The preparation obtained in the last experiment, although giving satisfactory evidence for approximate purity, was not crystalline. We therefore decided to work on a larger scale in order to obtain a crystalline product. We still found it convenient to work on small quantities of 100 gm. each, accumulating the copper compound from eleven such extractions. This, washed free from sulphate and decomposed in the usual manner, yielded 0·346 gm. of a crystalline product. This was undoubtedly pure glutathione. On rapid heating it melted sharply at 190°, and the product mixed with pure glutathione also melted at 190°. It gave the following analytical results, the mean of two closely agreeing duplicates: found C, 39·03; H, 5·52; N, 13·68; S, 10·36; glutathione, $C_{10}H_{17}O_6N_3S$, requires C, 39·09; H, 5·54; N, 13·68; S, 10·42.

Kozlowski[2] was the first to attempt the isolation of glutathione from peas. So far back as 1926, working in the Biochemical Laboratory at Cambridge, he spent much labour on the problem, employing as much as 25 kgm. of material for each extraction. He succeeded in proving the presence of non-protein cysteine but obtained no product identical with glutathione. After Hopkins[6] had described the use of cuprous oxide as a precipitant, he returned to the problem[7], but again was not successful in isolating a pure substance.

It will be remembered that Vivario and Lecloux[3] found that the production of –SH groups proceeded in powdered peas when this material was placed under water. We have confirmed and extended this observation.

Thunberg vacuum tubes were employed. Two series of –SH determinations were made. In one the powder had stood under an aqueous buffered solution; in the second it had stood under a similar solution to which the disulphide form of glutathione had been added. The following are the details of our procedure.

5 gm. of the pea powder was weighed into each of a series of large Thunberg tubes. 16 ml. of water and 2 ml. of *M*/5 Sørensen's phosphate buffer *p*H 6·0 were then added to each tube; to one series of tubes, 2 ml. of water, and to the others, 2 ml. of a solution of the disulphide form of glutathione containing 60 mgm. (neutralized to *p*H 6·0) were then added. The tubes were then evacuated, refilled with nitrogen and again evacuated; the procedure being repeated three times. The tubes were allowed to stand, with an occasional shake, at the room temperature of 17°. At intervals the reaction was stopped by sucking in through the side tube 10 ml. of acid (8 per cent trichloroacetic and 2 per cent metaphosphoric acids) as used by Musulin and King[8]. The precipitate was centrifuged off, successively washed with 5 per cent acid and made up to 100 ml. Half was titrated with 0·01 *N* iodine in the presence of potassium iodide, and the other half with Tillman's reagent using the micro method of Birch *et al.*[9] The iodine value of the very small amount of ascorbic acid as determined by the indophenol titration found under the conditions of our experiment at 18 hr. and 24 hr. has been deducted in the following table.

Hours	0·01 *N* iodine per 5 gm. peas (ml.)		Calculated for glutathione (mgm./100 gm. peas)	
	No GSSG*	+ GSSG	No GSSG	+ GSSG
0	1·4	—	85·96	—
4	2·0	6·2	122·80	380·68
12	2·0	7·6	122·80	466·64
18	2·0	8·8	122·80	540·32
24	2·3	9·1	141·12	558·74
24†	1·5	1·5	92·10	92·10

* GSSG = Disulphide form of glutathione.
† Heated for 15 min. at 70°.

To judge from many known cases, the production of sulphydryl groups is likely to depend on the transference of hydrogen from donators to acceptors capable of yielding –SH groups. In the present case these are likely to be the oxidized form of glutathione together with cystine. We do not yet know whether the former is present ready formed in the seed stores, or whether it may be synthesized rapidly when the necessary amino-acids are made available by proteolysis.

Thunberg, in a number of papers, has shown that dehydrogenases of various kinds are present in seeds, but we do not yet know which of these, if any, are concerned with the –SH production.

Our experiments with the powdered material show that the –SH groups are rapidly formed. Referring first to the preparations containing none of the disulphide form of glutathione, it will be seen from the above table that at the fourth hour their concentration has already reached a maximum.

It will be seen from the table that there was a considerable concentration of the –SH groups present in the pea powder we used for the experiment. This experiment was made at a time of the year when natural germination would occur. There is no doubt that when the atmosphere is warm and moist, reactions may begin in the intact pea.

We were led to try the effect of adding the oxidized tripeptide owing to a suspicion that the hydrogen acceptor groups were saturated before the hydrogen

supply was exhausted. It will be seen that, in consequence of this addition, a large increase in the titratable –SH groups was found.

In order to convey an idea of the extent of the reactions, we have converted the whole of the iodine values as though due to the reduction of the disulphide form of glutathione. It will be seen that the powder by itself reaches the relatively high figure of more than 140 mgm. per 100 gm., while with the addition of the disulphide form of glutathione it becomes no less than 540 mgm.

There is no doubt that the –SH groups start disappearing as soon as visible growth begins (see preparations 1 and 1*a*). We have made no attempt to ascertain the nature of their fate.

Summary

(1) When dry seeds are exposed to water, their contents come to display a high concentration of thiol groups, which rapidly reach a maximum. Later, when growth proceeds, there is a steady fall in the concentration of these groups.

(2) A method is described which has enabled us to isolate (from peas) pure crystalline glutathione.

(3) We have also worked with peas in the powdered form, and have found the same rapid production of thiol groups. The powder further displays a high reducing power towards the oxidized form of glutathione.

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PRINCIPLES OF THE USE OF NON-REFLECTING FILMS IN OPTICAL INSTRUMENTS*

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WHEN light from an object passes through an optical system to form an image, a small fraction is reflected at each air-glass surface instead of being transmitted. For normal incidence, the reflectivity is usually between 4 and 7 per cent, depending on the refractive index of the glass. This affects the image in three ways. First, the brightness of the image is reduced. Secondly, the reflected light, eventually reaching the image plane after two or more reflexions at the lens surfaces, invades the dark parts of the image and gives rise to a haze called 'veiling glare'. This reduces the contrast in the image. Thirdly, the reflected light may concentrate near the image plane to form 'glare spots' and 'ghost images'.

Optical systems are therefore only able to function at their best when unwanted surface reflexions are reduced to a minimum, and that is the purpose of non-reflecting films. The property of light on which they depend is that of interference, by means of which the distribution of the radiation is altered in such a way that the reflexion is reduced and the transmitted light increased. Nothing is sacrificed in reducing the reflexion.

Interference at a glass surface is brought about by coating it with a thin transparent film. As we are concerned with getting a reduction of reflected light, it is necessary, as will be shown later, that the film shall be of lower refractive index than the glass. Suppose, then, that a pencil of monochromatic light from a distant point source falls on a glass surface which has been coated with such a film (see diagram).

Consider the composition of the reflected ray R. As will be seen from the diagram, it consists of the reflected portion of the ray A, augmented by contributions from other rays such as B and C which emerge at A' in the direction $A'R$ after multiple reflexions within the film. Similarly, the reflected fraction of the multiple reflexions arriving at A' is added to the directly transmitted ray AT. The directly transmitted components of B, C, etc., and their reflexions at the first surface each become part of separate interference systems identical with the one being considered, so that whatever happens to the rays R and T applies equally to similar rays from any other point on the film.

The calculation of the intensity of the transmitted and reflected beams is tedious and is to be found in the text-books. As an introduction, however, a simplified calculation of the thickness and refractive index of a film giving no reflexion can be made by taking into account only the incident rays A and B. This is permissible because although a large number of incident rays contribute to the reflexion R, the amplitude of their contributions is very much attenuated by the multiple reflexions which they undergo before reaching A'.

The composite reflected ray R will have zero intensity when the components from A and B are in opposite phase and equal in amplitude. For the first condition, the optical path difference must be an odd number of half wave-lengths. For a film of thickness t and refractive index μ, the path difference is $2\mu t \cos r$, where r is the angle of refraction at the air-film boundary.

Therefore for minimum reflexion of light of wave-length λ

$$2\mu t \cos r = (2n+1)\frac{\lambda}{2},$$

n being an integer, whence

$$\mu t = (2n+1) \cdot \frac{\lambda}{4} \cdot \frac{1}{\cos r} \quad \ldots\ldots (1)$$

The condition of equality of amplitudes is met by equating the Fresnel formulæ (which hold for normal incidence and are almost correct for angles of incidence up to 20°) for the amplitudes of the rays reflected at the air-film and film-glass surfaces (refractive index of the glass, μ_g).

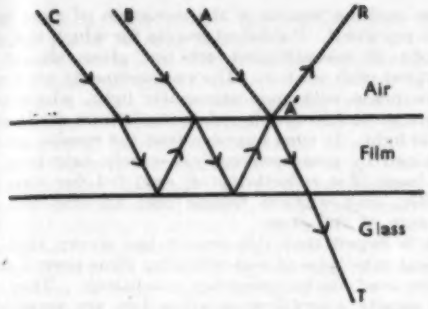
$$\frac{\mu - 1}{\mu + 1} = \frac{\mu_g - \mu}{\mu_g + \mu},$$

which gives

$$\mu = \sqrt{\mu_g} \quad \ldots\ldots (2)$$

It is not possible to calculate the exact effect on the transmitted beam of a film defined by equations (1) and (2) without taking into account all the multiple reflexions. It is clear, however, that with

* Substance of a lecture delivered before the Optical Group of the Physical Society on May 15, 1942.



such a film the fraction of the ray B which after internal reflexions is eventually superimposed on the ray AT must be phase with it, because in addition to the half-wave phase change introduced by the thickness of the film, the two reflexions of the ray from B are of different kinds, one being on the less dense side and the other on the more dense side of the reflecting boundary, which increases the equivalent path difference to one wave-length. The criteria for zero reflectance therefore also provide for increased transmission.

When all the multiple reflexions are taken into account the fraction of the incident intensity reflected from a film of which the refractive index obeys the condition of equation (2) is, for small angles of incidence,

$$\frac{4R\cos^2\frac{1}{2}\delta}{1+2R\cos\delta+R^2}, \quad . \quad . \quad . \quad (3)$$

where R is the reflectivity of the film material under the particular conditions of illumination and δ is $\frac{2\pi}{\lambda}\,2\mu t\cos r$.

The fraction transmitted is

$$\frac{(1-R)^2}{1+2R\cos\delta+R^2} \quad . \quad . \quad . \quad (4)$$

Now according to (3), the reflexion is zero when $\delta=(2n+1)\pi$. Putting δ in terms of path difference as given above, we obtain the optical thickness for zero reflectivity:

$$\mu t = (2n+1)\cdot\frac{\lambda}{4}\cdot\frac{1}{\cos r}.$$

This is the same result as that given by the simplified calculation, because the energy subtracted from the B contribution by internal reflexion at A', which was disregarded, is made up by the contributions through multiple reflexion from all the other incident rays.

When the condition $\delta=(2n+1)\pi$ is applied to the expression (4), we arrive at the interesting result that the transmitted fraction is unity, so that *all* the incident light is transmitted when the reflexion is annulled.

It is most important to realize that the rays do not in fact have to be reflected out into the air before they can annul each other. This is not the kind of interference system where the reflected rays have to be combined by a lens. The interference takes place at the interfaces, and the vectors at a point such as A' are such that there is no resultant intensity in the direction $A'R$. There seems to be a certain reluctance to accept the fact that a non-reflecting film can theoretically increase transmission to 100 per cent. I believe that this is largely due to attempts to explain the phenomenon without taking into account the multiple reflexions.

A film defined in refractive index and thickness by the equations (2) and (3) may be termed the 'ideal' film. Let us now discover, first, how the ideal film behaves under practical conditions of illumination and, secondly, how near an approach to the ideal film can be made with available materials and methods.

The angle of incidence enters into the expression for the transmitted or reflected intensities as a cosine function. This means that if a film is non-reflecting for normal incidence, it will be practically so for angles of incidence up to at least 20°. Within this limit such a film is therefore effective with a broad source, in convergent or divergent beams and on curved surfaces.

By adjusting the thickness of an 'ideal' film, extinction of reflexion could be obtained for any chosen angle of incidence up to about 45°. Above that angle, the condition (2) for the refractive index of the film no longer provides a correct balance of the intensities of reflexion at the two film boundaries. Curves showing the variation of reflectivity with these various factors have been published by Blodgett[1] in a very useful article on the properties of non-reflecting films.

Suppose a film thickness is chosen which gives zero reflexion for a monochromatic green light. If the colour of the light is then changed towards either the violet or the red, some will be reflected, the intensity of reflexion increasing as the wave-length moves away from the green until a maximum is reached. The reflectivity then decreases again as the wave-length approaches that which gives the next higher or lower order of interference. (The wave-lengths for zero reflexion due to successive orders of interference are obtained from equation (1) by putting $n = 0, 1, 2, \ldots$). If, then, white light is incident on a film which is non-reflective for a monochromatic green, there will still be no reflexion and maximum transmission of a wave-length in the green, but there will be a number of other maxima and minima within the spectral range, depending on the thickness of the film. If the film is thick compared with the wave-length of the light, there will be so many that the resulting reflexion will also be white, but with an intensity half that of the reflexion from unfilmed glass.

Now it so happens that if the optical thickness of the film is only *one* quarter wave-length of green light (for example, $\lambda = 5500$ A.), the nearest maxima are so far away ($\lambda = \infty$ and $\lambda = 2750$ A.) that the reflectivity for the red and violet is not more than 1 per cent. The filmed surface then reflects a faint purple colour. (When viewed by eye, the increase of reflectivity towards the ends of the spectrum is offset by the decrease in sensitivity of the eye.) The transmitted light is correspondingly increased but the slight excess of green light does not give perceptible colouring when only one or two surfaces are involved. The 'first order' minimum ($n = 0$) is therefore chosen for minimum reflexion over the broadest possible range of wave-lengths. The colour region of maximum transmission and minimum reflexion can, of course, be selected at will by choosing the appropriate film thickness.

Estimation of the thickness of a non-reflecting film is a very simple matter because the colour of the reflexion of white light is a sufficiently accurate measure. All the commonly used methods make the films by building up the thickness progressively, so

that as the film thickens the wave-length of first-order interference moves up through the ultra-violet and the violet. The reflected light therefore first diminishes in brilliance and turns yellow. As the wave-length of zero reflexion moves through the visible spectrum, the reflected light becomes orange, magenta, purple, blue, green and, when the minimum is in the near infra-red, greenish-white. The succession of colours is repeated with variations in intensity for successive orders of interference. The most useful colour, purple, denoting maximum transmission in the yellow-green, is a very sensitive indicator.

The refractive index of the film should be the square root of that of the glass. The effect of departing slightly from this condition is not serious: visually it results in a 'whitening' of the coloured reflexion because there will be a small residual reflexion at the wave-length of minimum reflectivity. (A 'purple' film of refractive index 1·35 on plate-glass would have a reflectivity in the yellow-green of about 0·6 per cent.) No attempt is made in practice to match the refractive index of films to every type of glass. Instead, a material is chosen which is reasonably well suited optically to a range of refractive indexes and has at the same time good mechanical properties. Silica, sodium aluminium fluoride (cryolite), and magnesium fluoride are commonly used.

A silica film has the great advantage that it is made of the substance of the glass itself, so that it is inherently a durable film. The film is formed by dissolving away the other constituents of the glass in such a way that the silica skeleton remains undisturbed and the polish of the surface is preserved. With glasses such as dense barium crowns and dense flints, the film can be formed naturally by the weathering action of the atmosphere. This 'tarnish' was first reproduced artificially by H. D. Taylor[2] in 1892, and the details of the chemical method are now well established[3]. Owing to the high refractive index of the silica film, even in its skeletonized state, it is only really effective on very dense glasses. Lately Nicoll[4] has described a new chemical method in which hydrofluoric acid vapour is the dissolving agent; good results are claimed with glasses of medium refractive index.

The fluoride films are deposited by the high-vacuum volatilization process[5], the technique being very similar to that used for making metal-on-glass mirrors. The powdered fluoride is evaporated by heating it electrically in a vacuum; it condenses in a vitreous film on any relatively cool surface directly exposed to the source. The surfaces to be coated are so placed that the condensed film is perfectly uniform in thickness. The vacuum is maintained by a fast mercury or oil diffusion pump at a pressure of not more than 10^{-4} mm. of mercury; by using very efficient pumps and taking great care to prevent leaks and evolution of gas in the vacuum chamber, the number of gas molecules can be reduced to as few as one million million per c.c.

The volatilization method generally gives a film of greater optical efficiency than does the chemical method. Magnesium fluoride forms very hard films and is a good match for the denser glasses, while cryolite is a good compromise for the whole range of optical glasses and can be made quite hard enough to withstand unavoidable handling.

In practice, it is found that a reflectivity in white light of not more than 1½ per cent may be expected and that a smaller loss than that is often achieved. Some striking results in the reduction of glare have been reported[6]. Published results for which the conditions of measurement are not given should be accepted with caution. The measurements are sometimes made with monochromatic light, which may give a more favourable result than those made with white light. It even happens that the results are not obtained by measurement but merely calculated on the basis of a reflectivity of, say, 0·4 per cent per surface, and without taking into account the absorption of the glass.

It is hoped that this survey has shown that the optical principles of non-reflecting films permit them to be used under everyday conditions. They are not merely scientific curiosities but are capable of bringing about a very real improvement in the performance of optical instruments.

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PERMEABILITY AND MOLECULAR CONSTITUTION AS FACTORS IN DRUG ACTION

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ONE of the chief difficulties in the interpretation of the analogies between the biological activity of a drug and its behaviour in synthetic systems arises from the ambiguity of toxicological data, which may generally be correlated with solubility in the cell lipoids (Overton-Meyer), adsorption at cell interfaces (Traube), or with other physico-chemical factors. Moreover, these analogies may not hold when other biological systems and homologous series of drugs are compared. Recent work on molecular interaction in monolayers has provided a very valuable guide to the factors which influence specific drug reactivity in pharmacological systems[1]. The principles which have been advanced have greatly extended the implications of the original conceptions of Overton-Meyer and Traube.

In the present article, an attempt is made to correlate existing pharmacological data and theories of drug action with experimental evidence which has resulted largely from a study of the mode of action of insecticides. This work, which was commenced some years ago in Prof. J. W. Munro's Department of Zoology and Applied Entomology at the Imperial College of Science and Technology, London, is at present being extended in the Department of Colloid Science, Cambridge.

Insects comprise a very wide range of biological systems which show a similarly wide range in susceptibility to different drugs. For example, mature blowfly larvæ (*Phormia terranovæ*) are resistant to high concentrations of drugs applied externally. The iso-active concentrations of alcohols and fatty acids which produce rapid paralysis or narcosis when injected internally into the hæmolymph are relatively inactive over prolonged periods when applied extern-

ally, showing that cuticle permeability may be a limiting factor in drug reactivity.

If a comparison is made between the relative external and internal biological activities of members of the homologous series of normal primary alcohols and fatty acids, a wide divergence is shown between corresponding homologues in both series. When *Phormia* larvæ are immersed in pure drugs, the rate of penetration of alcohols through the cuticle increases as the series is ascended from C_1 to C_8, when maximum biological activity is shown; from C_8 to C_9 there is a progressive decrease in biological activity. Under similar conditions of drug application, the rate of penetration of fatty acids decreases as the series is ascended from C_1 to C_8; from C_8 to C_7 there is a progressive increase in the rate of drug access (C_8 in the fatty acid series is solid at normal room temperatures, and is not suitable for comparison with the liquid drug members).

These results show clearly that drug access cannot be correlated directly with distribution in a heterogeneous system of immiscible phases comprising the external drug phase and the various biophases of the test insect. In homologous series, physical properties such as differential oil/water solubility, capillary activity, viscosity, or vapour pressure change uniformly in the *same directions* as drug chain-length increases. Neither can the divergence between the rates of drug access of corresponding homologues in both series be attributed to differences in concentration gradient across the bulk cuticle framework. The total decrease in molar concentration of pure drug is roughly fourfold as each series is ascended from C_1 to C_8; the absolute molar concentrations of corresponding members of both series are approximately equal.

Still further complications arise when a comparison is made between the relative threshold iso-active molar drug concentrations which produce paralysis when injected into the hæmolymph. The molecular activity of the alcohols increases as the series is ascended from C_1 to C_8, and the relation between biological activity and chain-length approximates to a typical exponential form which is characteristic of toxicological data expressing equilibria between drugs and biological systems. In the fatty acid series, the *iso-active molar drug concentrations remain relatively constant* as the series is ascended from C_1 to C_8. The molecular activity of formic acid is roughly 70–80 times that of methyl alcohol. In both series the intensity of paralysis or narcosis diminishes when the chain length exceeds C_8.

If the comparison between external and internal molecular drug activity is extended to the related series of blowfly larvæ (*a*) *Calliphora erythrocephala*, (*b*) *Phormia terrænovæ*, (*c*) *Sarcophaga falculata*, it is found that relative resistance to drugs applied externally increases in the order (*a*) → (*b*) → (*c*). When the drugs are applied internally by injection, iso-activity is shown by threshold narcotic drug concentrations in all three species of test insect.

This experimental evidence leads to the important conclusion that where diffusion through an intermediary biophase which links the site of drug application with the site of drug interaction is a limiting factor in drug access, relative biological activity measured at the site of drug application may differ from relative activity at the site of action. Drug reactivity may increase, decrease, or remain relatively constant as a homologous series is ascended, according to the mode and site of application.

If we attempt to elucidate the mechanism of drug access through the insect cuticle, it is first necessary to define clearly the nature of the drug interaction with the cuticle framework, which consists of a heterogeneous system of protein, lipoid, chitin, and other components[2]. The nature and relative distribution of these components vary considerably in different insects, but the fundamental cuticle *pattern* may be illustrated by some experiments which have been carried out on the cuticle of blowfly larvæ (for example, *Calliphora erythrocephala*).

Proteins and lipoid substances may be removed from the surface of the blowfly cuticle by the solvent or dispersant actions of water and fat solvents respectively, suggesting that the surface of the cuticle is not homogeneous but composite, consisting of heterogeneous protein and lipoid associations or patches. Similar tests with discrete layers of isolated cuticle indicate that there is a *continuity* of lipoid and protein components throughout the bulk cuticle framework. From this evidence, we may conclude that *functionally* the insect cuticle is analogous to a heterogeneous mosaic system comprising a protein phase associated with a hydrophobic lipoid phase.

An indication of the physical nature of the lipoid components of the cuticle is provided by a comparison of the 'carrier action' of different fat solvents. The primary association of fat solvents with the cuticle framework is physical, and the changes in permeability which are induced are readily reversible. For example, Calliphora larvæ, which are very resistant to pure ethyl alcohol, swell rapidly in ethyl alcohol-kerosene mixtures owing to induced penetration of alcohol by the functional participation of kerosene in the cuticle framework[3]. Penetration of alcohol ceases, however, when the insects are transferred to pure alcohol owing to 'wash-out' of the kerosene from the cuticle framework. After prolonged preliminary immersion in fat solvents, an irreversible increase in cuticle permeability takes place. This is shown by the rapid penetration of pure drugs such as methyl or ethyl alcohol. The rate of drug access is still further increased by fat solvents, showing that only a proportion of the lipoid components is dispersed or removed from the cuticle by fat solvent action. These experiments show that drug access cannot be explained by differential solubility in the lipoids of the cuticle, for if this were a limiting factor, removal of lipoid would tend to diminish drug access.

The physical nature of the oil carrier has a marked influence on the degree of induced drug penetration. Increase in carrier viscosity results in a corresponding decrease in drug access. If it is assumed that the oil carrier acts as a kind of 'diluent' in the lipoid centres, resulting in an increase in free volume of this phase, the variation in drug access with carrier viscosity may be explained by postulating a lipoid phase which is normally of high 'functional viscosity'. The term 'functional viscosity' is not strictly comparable with Newtonian viscosity in a homogeneous liquid, since the protein and lipoid components of the insect cuticle are heterogeneous visco-elastic systems comprising chemically linked networks enclosing the more mobile or labile components which may be removed by solvent action. 'Functional viscosity' gives a measure of the 'yield value' of the lipoid phase to drug diffusion pressure.

From these considerations, the increase in cuticle permeability which is produced by the association of fat solvents with the cuticle framework may be attributed to:

(*a*) A van der Waals' interaction between the fat solvent molecules and the lipoid centres, involving a reduction in mutual cohesion between the lipophilic elements or chains, and resulting in the production of a relatively open three-dimensional chemically linked network enclosing the more labile or liquid lipoid components in which the fat solvent molecules are present. In this way the fat solvent increases the free volume of the bulk lipoid phase, and may also act as a 'bridging' medium which links discrete lipophilic patches in the bulk cuticle phase. Since both protein and lipoid components are enclosed in an elastic lattice framework, alterations in the lipoid phase probably induce associated changes in molecular orientation in the protein phase. Fat solvent 'carrier activity' decreases with increase in viscosity, suggesting that the bulk lipoid phase is normally of high 'functional viscosity'. The main site of 'carrier activity' is in the outer epicuticle layer where lipoid components predominate.

(*b*) A secondary irreversible increase in the flexibility of the lipophilic lattice elements owing to rupture of the van der Waals' bonds which normally influence the stability and elasticity of the lipophilic chains. The elastic restoring forces of the lattice framework oppose the dispersive or disruptive action of the fat solvent. The irreversible increase in permeability is due to the removal of the labile 'bonding' components by fat solvent action, and also to a decrease in 'functional viscosity' of the bulk phase resulting from dispersive action of the fat solvent.

Additional evidence which supports the conclusion that the labile cuticle components act as a 'bonding' phase which regulates the cohesion of the chemically linked cuticle lattice elements is provided by the mode of action of insecticidal powders or dusts. Finely divided 'inert' powders such as quartz or charcoal readily adsorb the relatively labile lipoid or lipo-protein components from the surface of the epicuticle. This process is non-specific, and depends on the adsorptive and storage capacities of the powder, and also on the capacity for lipoid transmission at the epicuticle/powder interface. When the rate of removal of lipoid by adsorption displacement exceeds its rate of replenishment by transmission through the bulk cuticle phase, irreversible secondary changes are produced in the epicuticle framework. Depletion of the labile 'bonding' phase results in a reduction in lateral cohesion of the lattice elements owing to rupture or dispersion of cross-linkages. Once this stage is reached, the insect is unable to control the rate of transmission of water through the cuticle even when the external powder phase is removed, and rapid water loss soon results in death from desiccation. In the normal insect, variation in the rate of secretion of the 'bonding' phase by the epidermal cells may result in corresponding changes in free volume and 'functional viscosity' of the lipophilic centres in the epicuticle framework, thus providing a very sensitive regulatory mechanism for the control of water loss. Analogous effects, which have been obtained in synthetic systems, have provided a very useful basis for predicting the toxicity of insecticidal dusts.

Extending the above concepts of carrier action, we see that a drug may either induce its own penetration, or exert a carrier action similar to that of a fat solvent, provided that the dispersive van der Waals' interaction with the lipoid components is sufficiently strong. For example, access of ethyl alcohol may be induced by cetyl alcohol. In the homologous series of alcohols, 'carrier activity' increases to a maximum and then decreases as the series is ascended and capillary activity becomes pronounced. In fact, strongly capillary active alcohols such as cetyl alcohol exert 'negative carrier activity', or antagonism, on the rate of access of a lower homologue such as amyl alcohol. In the fatty acid series, 'carrier activity' becomes pronounced at a later stage (C_8–C_9) than in the alcohol series (C_4–C_5).

This change in 'carrier activity' with capillary activity has a very direct bearing on the mechanism of drug access, for it suggests that a two-dimensional diffusion takes place along the internal lipoid/protein interfaces of the bulk cuticle framework. Within the range C_1–C_3 the adhesion between the hydrocarbon chains of the drug molecules in the series of alcohols and fatty acids is small, and the adsorbed molecules form mobile 'gaseous' surface films[4]. Drug access will depend on (*a*) the association of the polar portions of the drug molecules with the aqueous protein phase, (*b*) the van der Waals' association between the hydrocarbon chains of the drug molecules and the lipoid phase, and (*c*) the interfacial viscosity at the Gibbs' layer.

Two-dimensional drug diffusion along the Gibbs' layer does not preclude three-dimensional diffusion through the bulk lipoid and protein phases of the cuticle, but with this definition of the drug-cuticle phase distribution relations it becomes possible to co-ordinate the gross divergence in drug access between alcohols and fatty acids which was recorded earlier in the present article.

Weak polar interaction of alcohols with the proteins of the cuticle is insufficient to induce penetration through the protein phase. Similarly, the weak van der Waals' interaction of the lower members (C_1–C_3) with the lipoids results in feeble 'carrier activity' within this range. As the series is ascended from C_1 to C_3, the increase in 'carrier activity' owing to dispersive action of the alcohols on the lipoids results in a progressive increase in cuticle permeability. A specificity factor appears to be involved in the non-polar association of the drug molecules with the lipoids of the cuticle, for dispersive action decreases as the series is ascended further from C_3 to C_5, in which range drug access also decreases. The ambiguity between the 'rival' theories of drug reactivity which were mentioned at the beginning of this article, disappears when we consider the physico-chemical factors which influence penetration of amyl alcohol through the cuticle. The intermediary stages in drug access involve the following steps. (i) Differential solubility in the cuticle lipoids resulting in a decrease in 'functional viscosity' of this phase; this agrees with the Overton-Meyer theory of lipoid solubility. (ii) Adsorption at the lipoid/protein interfaces or Gibbs' layer in the cuticle framework mosaic; this is in accordance with the Traube concept of drug adsorption at interfaces. (iii) Molecular interaction with the functional cuticle components at the Gibbs' layer; owing to weak polar interaction with the protein components, there will be little tendency for the drug molecules to become 'anchored' at the Gibbs' layer, and the mobility of amyl alcohol will now depend on the interfacial viscosity. The antagonistic action of carriers of high capillary activity (for example, cetyl alcohol, oleyl alcohol, cholesterol, or oleic acid) on access of drugs of lower capillary activity may be attributed to selective blocking of the Gibbs' layer by the carrier components of the drug mixture. The penetration of lower alcohols (for

example, ethyl alcohol) is induced by carriers of moderate capillary activity (for example, octyl alcohol) because the increase in drug mobility owing to dispersive carrier activity is a more important factor than the opposing influence of selective carrier adsorption at the Gibbs' layer. The rapid drug penetration which is induced by non-polar solvents such as kerosene may be attributed to pronounced carrier activity and negligible carrier adsorption at the Gibbs' layer.

The strong polar interaction of fatty acids with the protein components of the cuticle is sufficient to induce selective penetration through the protein phase[5]. Phormia larvæ, which will survive for at least two hours in methyl alcohol, are killed within three or four minutes when immersed in formic acid. We can visualize a kind of competition between the lipoid and protein components of the cuticle for the fatty acid drug molecules. Where chain-length is short (for example, formic acid) polar group interaction will be a limiting factor in drug access. The penetration and expansion of synthetic monomolecular amine and protein films by carboxylic acids suggest that the penetration of a fatty acid through a three-dimensional protein gel involves a preliminary rupture or dispersion of salt interlinkage systems (for example, $-\overset{-}{C}OO\ \overset{+}{N}H_3-$) owing to competition from the polar groups of the drug molecules. As capillary activity increases, the drug molecules will tend to become anchored at the external layer of the cuticle owing to a balance between the polar and non-polar interaction of the drug molecules with the lipo-protein associations at the Gibbs' layer. The stability of the lipo-protein-drug association reaches a maximum at C_8, when drug access is at a minimum. From C_8 to C_7 this stability decreases as the influence of non-polar interaction begins to predominate over the competing influence of polar interaction. Dispersion of the lipoid phase now becomes a limiting factor in drug access, and this carrier activity accounts for the increase in drug reactivity within this range.

The relative internal drug reactivities may be explained from similar considerations. Within the range C_1–C_8, the logarithmic increase in molecular activity of the alcohols may be attributed mainly to non-polar interaction of the drug molecules with the lipoid loci at the site of action; the relative influence of head group interaction of the 'inert' drug molecules with the protein receptors is negligible. This explains the fact that the relative molecular activities of the alcohols form a typical Traube series. The iso-activity of the fatty acid molecules within the range C_1–C_8 suggests that drug reactivity is influenced mainly by polar interaction with the protein receptors. A factor of non-polar specificity is suggested by the iso-activity of alcohols and fatty acids at a chain-length of C_8; in both series the intensity of narcosis decreases with further increases in chain-length. It is of interest that where the drugs are present as an external phase, a similar factor of non-polar specificity results in a maximum divergence between the relative rates of drug access of corresponding homologues in both series.

The principles which have been proposed in the present article have been based on a very restricted range of pharmacological systems. The fundamental components of a pharmacological system may be resolved into (i) the biological system; (ii) the drug; (iii) the carrier. The ambiguity of existing theories of drug interaction disappears when the relationships of *all* the components in the system are taken into consideration. Failure to recognize the fact that each constituent of a drug mixture may contribute towards gross toxicity imposes a severe restriction on the general application of 'standard' methods of drug bio-assay, especially in connexion with methods which have been proposed for the biological evaluation of insecticides[6]. The general tendency has been directed towards arbitrary elimination of the disturbing influence of unknown variable factors, and 'evaluation' of an insecticidal mixture has been based on the assumption that the main function of a carrier medium is to bring the drug into contact with the biological system, after which drug concentration provides the limiting factor which determines biological activity. The only 'official' test which is at present in use for the evaluation of contact liquid insecticides is the Peet-Grady method[7], in which houseflies are liberated into a specially designed cubical spray chamber and then sprayed with a standard 'dosage' of reference insecticide; comparison is then made with the results of a similar test using an insecticidal mixture of unknown composition. It has generally been assumed also that 'mist action' of the finely atomized spray is mainly responsible for 'knock-down' action. The flaws in these assumptions are shown by the fact that, under similar conditions of application, a given concentration of contact insecticide (for example, 0·1 per cent pyrethrins) in kerosene produces a rapid 'knock-down' action; a similar concentration of pyrethrins in a heavier oil of the medicinal paraffin type produces a negligible 'knock-down' action, and cannot be 'evaluated', although the mist action is superior to that produced by the lighter oil. This is due to the rapid penetration of pyrethrins which is induced by the kerosene; despite a pronounced mist action, the shortness of the mean life of the atomized heavier oil droplets precludes 'knock-down' action, since carrier activity is relatively slight in comparison with the kerosene spray.

If we extend the principles which have been here elucidated, we see that drug access in an extremely wide range of biological systems may be explained on the assumption that these systems are of the same fundamental *pattern* as insect cuticle. In other words, a visco-elastic lipo-protein mosaic appears to be a common factor in the organization of living biological systems. For example, physico-chemical factors which influence drug access through insect cuticle also apply to drug access through other arthropod integuments, the cuticles of nematode parasites, and various vertebrate pulmonary, muscle, and nerve tissue lining membranes. The analogy may be extended to microscopic systems such as red cells, where the surface is said to consist of a molecular lipo-protein mosaic[8]. Reversible disk-sphere transformations may be produced by primary interaction of fat solvents with the ultra-structure of the red cell. Prolonged interaction disrupts or disperses the lipo-protein associations and results in hæmolysis. The chain of analogies also bridges the gap between animal and plant systems. There is a parallelism between the outer 'cutinized' layer of plant epidermal tissues and insect epicuticle.

If we now consider the drug components, we see that the range of drugs which shows the effects of induced penetration by fat solvents includes feebly dissociating alcohols, ketones, fatty acids, amines, and phenols. The drugs penetrate as unionized molecules. This is in agreement with their greater activity

in carriers of low dielectric constant, and also with maximum adsorption at the Gibbs' layer.

The carriers which facilitate drug access include a wide range of aliphatic and aromatic fat solvents. Generally, carrier activity decreases with increase in capillary activity.

Finally, this review of the fundamental analogies between different pharmacological systems may be concluded by stressing the fact that the analogies between liquid drug systems also apply to drugs and drug mixtures in the vapour phase. For example, a mixture of fumigants may be more toxic to insects than the separate components. This may be attributed to the condensation and functional association of the drug components with the cuticle framework.

A full account of the above work will be given elsewhere.

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NEWS and VIEWS

Anglo-American Unity and World Peace

ANGLO-AMERICAN unity was the theme of the address delivered by Mr. Churchill when he received the honorary degree of doctor of laws at Harvard University on September 6. American participation in international affairs, Mr. Churchill said, is not only necessary but also inevitable. Twice in a generation the American people have been drawn into a major war, and a new world order is impracticable without their active participation; the "price of greatness is responsibility". Collaboration among the United Nations has now brought us to a point where there can be no pause. "It must be world anarchy or world order." A potent factor in promoting the joint action of Great Britain and the United States has been the Combined Chiefs of Staff Committee, working immediately under President Roosevelt and Mr. Churchill. This body has reached the stage when it ignores distinctions between things American and British, and disposes of troops, equipment, transport and munitions as if they were the resources of a single nation. This powerful and smoothly running system should not be broken up until we are assured of a practicable form of world security. Looking specifically to the future, Mr. Churchill remarked that various schemes for achieving world security while safeguarding national rights and traditions are being studied. Good work was done in this direction by those who devised the League of Nations, which became ineffective because it was abandoned and its best friends infected with pacifism. "We have learned from hard experience that stronger, more efficient, more rigorous world institutions must be created to preserve peace and to forestall the causes of future wars."

The possession by Great Britain and the United States of a common tongue is, Mr. Churchill said, a priceless inheritance which has smoothed the way to collaboration and "may well some day become the foundation of a common citizenship". Indeed, Mr. Churchill looks beyond that to spreading the English language even more widely throughout the world, and he mentioned that he had persuaded the British Cabinet to set up a Committee of Ministers to study and report upon Basic English. No doubt this committee will take account of the discussions on the use of an auxiliary world language being conducted by the British Association Committee on Post-War University Education and by the Association of University Professors and Lecturers of Allied Countries in Great Britain (see NATURE, December 19, 1942, p. 716 and August 21, 1943, p. 221). Harvard, Mr. Churchill said, has done more than any other American university to promote the use of Basic English, through its Commission on English Language Studies, which has introduced the use of Basic English in Latin America, and is working with certain secondary schools on its use in teaching English to American children and to foreigners preparing for American citizenship. With characteristic understatement, Mr. Churchill remarked, "it would certainly be a grand convenience for us all to be able to move freely about the world . . . and to be able to find everywhere a medium, albeit primitive, of intercourse and understanding".

Barricade Against Spread of Rinderpest in Africa

LATE in 1939, there was news of rinderpest in the south of Tanganyika Territory. Brought originally from Asia, the virus of the disease found a new home in the game and cattle countries in the interior of East Africa. Here those animals which recovered from the first attacks had gained some immunity, thereafter acting as reservoirs of the virus. Then during the War of 1914–18 German manœuvres had carried infected oxen right down to Lake Rukwa in southern Tanganyika, and it seemed that this area might now become the source of further spread towards the south. Consultation between all the Governments of East, Central and South Africa achieved certain conclusions, foremost among them being that at all costs the disease must be stopped from crossing the border between Tanganyika Territory and Northern Rhodesia. Mass inoculations created a safe zone in which the rinderpest virus could not maintain a hold among the cattle. There remained the wild game. The problem was to break the contact between the game in Tanganyika Territory and that in Northern Rhodesia and Nyasaland to the east. Nyasaland is well protected naturally by closely settled belts of native population and a broad river running between high hills; but there is little on the Northern Rhodesia border to check the passage of game. It was decided, therefore, to build a fence along the danger line, from the south end of Lake Tanganyika to the Nyasaland border, a distance of more than 160 miles. The fence was started in August 1940. A stockade seven to ten foot high was made of timber near to hand; only through timberless open plains could the very limited supply of wire

be used, fifteen miles in all. The whole fence was finished within a year from the start.

Constant vigilance is necessary to keep the fence in daily repair. Elephant on their customary journeys have smashed through the structure time and again; but fortunately elephant do not carry rinderpest. A human cordon ran the length of the fence: pickets of native African guards, patrolling and linking up each day so that nothing could get through without detection, all under two white officers' supervision. At the eastern end of the fence Nyasaland linked up and carried the human cordon down to the shores of Lake Nyasa, thus completing the great barrier between the two lakes. The game in the fence zone is gradually being pushed back on either side, and in time the danger of contact between north and south should pass away. But the fence itself has proved so valuable in controlling the position that attempts are now being made to prolong its life indefinitely by trenching (the best security against wild pigs) and planting thorns and sharp-spiked sisals which will discourage any buffalo or soft-skinned game from approaching even if they do escape the vigilance of the hunters.

New Synthetic Rubber

A NEW specialty rubber known as 'Paracon' has been developed by the Bell Laboratories, which looks and feels like ordinary rubber and resembles it fairly closely in mechanical properties (*Bell Lab. Rec.*, 20, No. 9; May 1943). It has a high resistance to damage by oil or petrol and is better than natural rubber in resistance to heat, light and oxidation, although inferior to it in resistance to steam, alkalis and acids. 'Paracon' can be worked with ordinary rubber machinery. In its raw state it is highly plastic and unusually well adapted to moulding into intricate shapes and to use in producing rubberized fabrics. 'Paracon' does not compete with other synthetic rubbers for its basic raw materials since the chemical intermediates required for its production are derived by other trains of chemical processes. For its synthesis it uses materials derived from agricultural products and coal products, or from coal and petroleum sources, and in each case by a variety of different chemical processes. The equipment for manufacturing 'Paracon' differs from that required for synthetic rubber production and, consequently, the new material can add to the present supply of rubber substitutes without interfering with the production of those already under way. The synthesis of 'Paracon' was accomplished by Drs. C. S. Fuller and B. S. Biggs of the Bell Laboratories and their associates.

Public Health in Peru

THE February issue of the *Boletin de la Oficina Sanataria Panamericana* contains an article on public health in Peru by Dr. Manuel Prado, president of the Republic, who states that during 1941–42 more attention has been given to it by the Government than ever before. Owing to the general census of 1940 much more accurate data have been made available. The birth-rate, for example, is now found to be rising in many of the provincial capitals, while the death-rate remains unchanged in most of the villages. Considerable attention has been given to children. In addition to the Children's Hospital, which receives children not only from Lima but also from neighbouring villages and towns, there is a National Children's Institute which has made possible the creation in various cities of sections of maternal aid, social hygiene, maternal education and food dispensaries. An intense campaign has been carried out against disease, especially tuberculosis and malaria. Clinics for tuberculosis have been established in three cities and others will soon be formed. A portable X-ray apparatus has been provided for rural communities as well as other means for the diagnosis and treatment of this disease. The Rockefeller Foundation is now collaborating with the Peruvian Ministry of Health in an effort to free the valleys of the coast from malaria. Preventive measures are reducing the foci of other diseases, particularly venereal diseases. First-aid services are assuming greater importance not only for minor accidents but also for major catastrophes. The value of sanitary engineering has recently been proved by its control over bathing establishments and markets, and over food, especially milk.

Narcotic Drug Addicts

IN Supplement No. 170 of *Public Health Reports* Dr. Michael J. Pescor, assistant surgeon, United States Public Health Service, records a follow-up study of 4,766 narcotic drug addicts who had been discharged from the United States Public Health Service Hospital at Lexington, Kentucky, during January 1, 1936–December 31, 1940. The results were as follows: The present state could not be determined in 39·6 per cent of the cases; 7·0 per cent died after discharge; 39·9 per cent returned to the use of drugs and 13·5 per cent were still abstinent. Excluding the dead and the unknown, 74·7 per cent had relapsed and 25·3 per cent were still abstinent. 57 per cent of the patients gave no history of subsequent admission to any institution; 19·9 per cent were re-admitted to other institutions, 16·0 per cent returned to the Lexington Hospital only and 7·1 per cent were re-admitted both to the Lexington Hospital and other institutions. According to Pescor the theoretically ideal patient, that is the one with the best prospects for a permanent cure, is the one who stays in the hospital for 2–5 months, after which he is discharged on parole for a period of supervision of 2–5 months, during which he would have home employment.

Poliomyelitis in the Argentine

ACCORDING to the *Journal of the American Medical Association* of February 6, the number of cases of acute poliomyelitis in the Argentine since last November was greater than in previous epidemics and the course of the disease has been similar to that of the 1936 epidemics. About four hundred cases were reported in two months in the epidemic area, in which more than seven hundred cases were observed during the whole epidemic period of five months in 1936. Separate wards and six hundred beds in various hospitals have been reserved for cases of the disease. Good results have recently been reported from the use of tetanus toxin.

Prevention of Blindness

THE Department of Health for Scotland has recently issued a circular containing the following advice to local authorities on the prevention of blindness: (1) A wider use should be made of special schools and classes for children whose eyesight is defective, arrangements being made with neighbouring authorities when necessary. (2) There should be a closer connexion with industrial medical services to

ensure that children leaving school and entering industry are not given jobs making heavy demands on defective eyesight. (3) Facilities for expert consultation and treatment of infections responsible for blindness should be increased. (4) Travelling expenses should be defrayed to treatment centres, of both the patient and a companion.

The Faraday Society

THE Faraday Society has arranged a discussion on "Modes of Drug Action", to be held at the Hotel Rembrandt, London, S.W.7, on September 24. There will be morning and afternoon sessions, at which introductory addresses will be given by Prof. J. H. Gaddum and Prof. E. K. Rideal, devoted respectively to biological and physico-chemical aspects of the subject.

Association for Scientific Photography

THE first meeting of the session for 1943–44 of the Association for Scientific Photography will be held on September 18 at the Middlesex Hospital, London, W.1, to discuss papers on clinical photography. Future meetings will be held monthly; the October meeting will deal with the use of photographically sensitized metal, wood and plastics in industry, the November meeting with oscillographic recording, and the December meeting will be devoted to an exhibition of scientific photographic apparatus arranged jointly with the Scientific and Technical Group of the Royal Photographic Society. Further particulars can be obtained from the honorary secretary of the Association, Tavistock House North (1st floor), Tavistock Square, London, W.C.1.

ASLIB Conference

THE ASLIB Conference, 1943, to be held in the rooms of the Royal Society, Burlington House, London, W.1, during September 18–19, has been designed to provide a platform for discussion of some of the outstanding problems of the rehabilitation of special library and information services after the War, chiefly to give a lead to immediate action. The whole of Saturday afternoon has been given to a symposium on rehabilitation and it is hoped that the discussion will bring the British, American and European needs and opportunities into proper relationship. At the inaugural meeting of the Conference, Prof. J. D. Bernal, as a man of science who has always placed a high value on the positive function of information services at the centre of scientific activity, will draw a picture of what must be expected of information services if they are to fulfil this positive function in the scientific life of the post-war world. Further information can be obtained from the Secretary, ASLIB, 31, Museum Street, London, W.C.1.

Miners' Welfare Scholarships and Exhibitions

THE Trustees of the Miners' Welfare National Scholarships and Students' Exhibitions Funds announce the award of nineteen scholarships and nine exhibitions in 1943, as follows:

Scholarships:

Francis D. Davies, of Dinnington, Yorkshire, tenable at the University of Sheffield; Kingsley R. Fox, of Fenay Bridge, Yorkshire, tenable at the University of Leeds; Geoffrey F. Gill, of Barnsley, Yorkshire, tenable at the University of Sheffield; Raymond Hall, of Bakestone Moor, Nottinghamshire, tenable at the University of Sheffield, for honours degree courses in mining; Robert H. Kirkup, of Radcliffe, Northumberland, tenable at King's College, University of Durham, for an honours degree course in electrical engineering; Edward M. Robson, of Monkseaton, Northumberland, tenable at King's College, University of Durham, for an honours degree course in mining; Ernest Blewitt, of Cudworth, Yorkshire, tenable at Selwyn College, University of Cambridge, for an honours degree course in natural science; Ben R. Brown, of Swinton, Yorkshire, tenable at the University of Manchester, for an honours degree course in chemistry; Jeffrey Ellison, of Old Sharlston, Yorkshire, tenable at the University of Leeds, for an honours degree course in colour chemistry; James B. Finean, of Wombwell, Yorkshire, tenable at the University of Birmingham, for an honours degree course in chemistry; Thomas G. Griffiths, of Cilfrew, Glamorganshire, tenable at Queen's College, University of Oxford, for an honours degree course in modern languages; Jean Haswell, of Clipstone, Nottinghamshire, tenable at the University of Reading, for an honours degree course in English; Joseph Hutchinson, of Kimblesworth, Co. Durham, tenable at King's College, University of Durham, for a degree course in dental surgery; Harry O. Morton, of Balby, Yorkshire, tenable at King's College, University of Cambridge, for an honours degree course in natural science; Thomas A. I. Tees, of Twyn, Carmarthenshire, tenable at the University College, Cardiff, for a degree course in medicine; Mavis Sheppard, of New Ollerton, Nottinghamshire, tenable at King's College, University of London, for an honours degree course in English; Gordon B. Skingle, of Chesterfield, Derbyshire, tenable at University College, Durham, for an honours degree course in modern languages; Graham Turner, of Shuttlewood, Derbyshire, tenable at Queens' College, University of Cambridge, for an honours degree course in natural science; Paul A. N. Wainwright, of Billinge, Lancashire, tenable at the University of St. Andrews, for a degree course in medicine.

Exhibitions:

Harry Allison, of New Herrington, Co. Durham, tenable at King's College, University of Durham, for an honours degree course in agriculture; Drummond H. Bowden, of Abercynon, Glamorganshire, tenable at the University of Bristol, for a degree course in medicine; Bridget Cairns, of Kelty, Fifeshire, tenable at the University of Edinburgh, for an honours degree course in physics; Henry P. Clement, of Willington, Co. Durham, tenable at King's College, University of Durham, for an honours degree course in chemistry; Kathleen M. Dawson, of Newbiggin-by-Sea, Northumberland, tenable at St. Hilda's College, University of Durham, for a course for the diploma in education; David Jenkins, of Llanharan, Glamorganshire, tenable at the University College of Wales, Aberystwyth, for an honours degree course in geography; Betty M. Linford, of Royston, Yorkshire, tenable at Newnham College, University of Cambridge, for an honours degree course in history; Jean M. McLachlan, of Girvan, Ayrshire, tenable at the University of Glasgow, for an honours degree course in chemistry; Henry A. Rigby, of Swinton, Yorkshire, tenable at Exeter College, University of Oxford, for an honours degree course in chemistry.

ERRATUM. In the article "Edmond Halley and Geomagnetism" in NATURE of August 28, on p. 232, col. 1, line 6, for "shell" read "skill".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Long-term Cultivation *in vitro* of a Dibenzanthracene Mouse Sarcoma

ATTEMPTS to culture *in vitro* over long periods chemically induced sarcomas appear to have met almost universally with failure[1,2]. It seems therefore justified to report briefly on a pure *in vitro* strain of fibroblastic sarcomatous cells, derived from a dibenzanthracene mouse tumour, which was kept *in vitro* for slightly more than two years. The special architecture of these colonies described in a previous communication[3] was maintained with little variation throughout the culture period. The figure shows part of such a colony after 703 days of *in vitro* growth. The cultures were kept in Carrel flasks (coverslip passages, except in a few initial ones, were unsuccessful) in a dilute hen plasma coagulum containing 5 per cent chick embryo juice, and were fed twice weekly with a hen serum (0·2 c.c.)–chick embryo juice (0·05 c.c.)–Tyrode (0·55 c.c.) mixture. Transplantations were made according to the state of health, the cultures being examined daily. When the cultivation was discontinued, the strain had reached its thirty-eighth passage.

Great fluctuations in extent of growth and viability were experienced. As these cells practically fail to liquefy the coagulum, it was found essential to ensure a removal—as thorough as possible—of the aged adherent plasma clot because of its inhibitory action[4]. This was achieved either by mechanical manipulation under a dissecting microscope or by a short trypsin digestion as used by Vogelaar and Erlichman[5] for other types of cultures. The latter treatment was sometimes followed by a quicker and more vigorous outgrowth, and sometimes by complete disintegration; a number of cultures were lost in this way. The presence or the gradual formation in some sera of a substance toxic to these tumour cells, but not to homologous macrophages, was another source of danger to the life of these cultures. Therefore samples of different sera had to be kept in store. If the cytolytic action of a serum was discovered in time when only the peripheral cells had been affected, replacement of the deleterious serum by an innocuous one would result in recovery and save the cultures. The latent period (that is, time elapsed until the first cells wander out into the new coagulum), which is only a few hours from fresh tumour explants, became considerably lengthened with life *in vitro*, and was, during the last months, two days or more, during which time the cultures look almost like dead pieces of tissue.

The rate of *in vitro* growth is very slow compared with normal chick embryo fibroblasts. Area measurements made on sister cultures showed a fair agreement which would encourage closer quantitative work on these cultures were it not for the great difficulty of having cultures available in sufficient numbers. At its best the strain comprised about thirty cultures at a time, all derived from a single original culture.

Inoculations made from time to time of cultures into mice reproduced in some instances the original sarcoma, but the frequency of takes decreased with time of *in vitro* cultivation. After 393 days of *in vitro* growth, even a massive dose (5 cultures per mouse) injected into three animals failed to produce a tumour. The impossibility of increasing the strain substantially during the second year of cultivation prevented further inoculation tests apart from two cultures which were finally left and injected into a mouse; again no tumour resulted. It is difficult to account for these failures. Neither Ludford's[2] contention that the presence of macrophages is an essential feature in the invasive growth of tumours, nor Earle and Voegtlin's[6] tentative suggestion, put forward in a slightly different context, that the foreign medium employed might be responsible for the lack of takes, seems to afford a tenable explanation, as repeatedly some sarcomas were produced, in these studies, from pure fibroblastic sarcomatous colonies grown in an entirely heterologous medium during the first year. It seems possible to relate the failure of takes to the very long latent period observed *in vitro* after transplantation. If there is a similar delay after inoculation into an animal, the culture cells might die before they gain a foothold and/or the animal would be enabled to mobilize in sufficient strength its defence apparatus (leucocytes and antibodies) to cope effectively with the culture material introduced. Alternatively, it has to be assumed that the sarcoma cells have lost their malignancy or what power of autonomous growth they possessed. It must remain for future investigations to throw light on this problem.

SARCOMA CULTURE (*Fl* 10385*b*) LIVING, AFTER 703 DAYS *in vitro*; 31ST PASSAGE, 10 DAYS AFTER LAST TRANSFER. × 55.

I wish to thank the Birmingham Branch of the British Empire Cancer Campaign for a grant which supported this work.

F. JACOBY.

Department of Physiology and
Cancer Laboratories,
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Birmingham, 15.
Aug. 3.

[1] Lewis, W. H., *Arch. exp. Zellf.*, **23**, 8 (1939).
[2] Ludford, R. J., *Brit. Med. J.*, 201 (1940).
[3] Jacoby, F., NATURE, **146**, 301 (1940).
[4] Olivo, D. M., *Monit. zool. ital.*, 42 Suppl., 147 (1932).
[5] Vogelaar, J. P. M., and Erlichman, E., *Amer. J. Cancer*, **35**, 510 (1939).
[6] Earle, W. R., and Voegtlin, C., *Publ. Health Reports*, **55**, 303 (1940).

A Serum that Discloses the Genotype of some *Rh*-Positive People

THE blood-group antigen *Rh*, present in the red blood cells of about 85 per cent of normal people, called *Rh*-positive, and absent in the rest, *Rh*-negative, plays, with its corresponding anti-*Rh* agglutinin, an important part in the causation of erythroblastosis fœtalis, a familial disease of the new-born. In about 90 per cent of cases of the disease the mother is *Rh*-negative and has made anti-*Rh* which passes through the placenta and damages the red blood cells of her *Rh*-positive fœtus. The *Rh* factor is inherited as a dominant character with three genotypes *RhRh*, *Rhrh* and *rhrh*.

Recently we have found in the serum of the *Rh*-positive mother of an erythroblastotic baby an agglutinin capable of disclosing the genotype of some *Rh*-positive people. This serum, sent to us by Dr. A. J. McCall as containing anti-*Rh* and yet being from an *Rh*-positive mother, we call *St* from the first two letters of the mother's surname. It reacts with the blood of all *Rh*-negative and of all heterozygous *Rh*-positive persons, *Rhrh* (recognized by being *Rh*-positive parents or children of *Rh*-negative subjects), but it fails to react with about 20 per cent of bloods all of which must, therefore, be homozygous, *RhRh*, and represent about half of the *Rh*-positive homozygotes (about 38 per cent of the population). The *St* serum is somewhat similar to the anti-*Hr* serum found by Levine, Javert and Katzin, and referred to by Wiener[1]. The latter serum, like *St*, reacted with all *Rh*-negative bloods, but whereas *St* failed to react with only 20 per cent, the anti-*Hr*, apparently, failed with about 50 per cent of people[2]. Our findings with *St* serum, and family details, are given below.

	St+	*St*—	Total
General population	173	45	215
Rh-negative bloods	100	0	100
Rh-positive heterozygous bloods	32	0	32

Mrs. St.	*O.MN. Rh*+. *St*—.
Mr. St.	*A*$_1$*.MN. Rh*+. *St*+.
Eldest son	*O.N. Rh*+. *St*+.
2rd son	Died of erythroblastosis fœtalis.
3rd son	*O.MN. Rh*+. *St*+., recovered from erythroblastosis fœtalis.

It follows that certain rules can be formulated concerning parentage in general:

(*a*) An *St*-negative child must have both parents *Rh*-positive. (*b*) All children of an *St*-negative parent must be *Rh*-positive.

In families with erythroblastosis fœtalis due to anti-*Rh*:

(1) All mothers and children must be *St*-positive. (2) The only member who can be *St*-negative is the father. We have found no exception to these rules. (3) The father will be more frequently *St*-negative, since he is always *Rh*-positive, than will fathers of normal children. (4) If a father is *St*-negative he must be homozygous, *RhRh*, and so cannot produce an *Rh*-negative child. His chance of producing a child without the disease is, therefore, extremely remote. (5) If the great majority of fathers of erythroblastotic infants are homozygous, a conclusion to which we and our collaborators have been led by other observations[3], about half of them should be *St*-negative. We have so far found eight out of twenty-one to be *St*-negative. The examination of a larger number should show the extent of any preponderance of homozygous fathers.

There is ample evidence that there occur subgroups of *Rh* somewhat similar to those of the *ABO* system of groups, and to explain the findings that have been reported[1–4], it is certainly necessary to postulate three allelomorphic genes (*Rh*$_1$, *Rh*$_2$ and *rh*) and almost certainly four (*Rh*$_1$, *Rh*$_2$, *Rh*$_3$ and *rh*). It is tempting to equate the frequency of the genotype *Rh*$_2$*Rh*$_2$ to 0·20, the proportion of people whose cells fail to react with the *St* serum. If the frequency of the gene *Rh*$_1$ is so derived, it may be estimated that people of the genotypes *Rh*$_2$*Rh*$_3$ and *Rh*$_3$*rh* form about one sixth of all *Rh*-positive persons. It is noteworthy also that Wiener[1], from the behaviour of an anti-*Rh* serum that failed to react with about 16 per cent of *Rh*-positive bloods, thought that one sixth of all *Rh*-positives belonged to the 'subtype' *Rh*$_2$.

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Emergency Public Health Laboratory Service.
Aug. 17.

[1] Wiener, *Amer. J. Clin. Path.*, **12**, 202 (1942).
[2] Levine, Katzin, Vogel and Burnham, in "Blood Substitutes and Blood Transfusion", p. 317 (Springfield, Illinois: Mudd and Thalhimer, 1942).
[3] Race, Taylor, Cappell and McFarlane, *Brit. Med. J.* (in the press).
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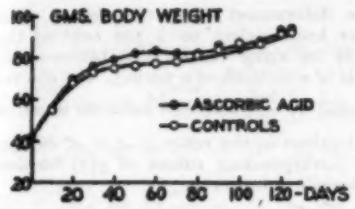
Vitamin C Requirements of the Syrian Hamster

WHILE engaged in some endocrinological and immunological work on the Syrian hamster, we became interested in the diet of this animal. It was thought of interest to examine the ascorbic acid requirements of the hamster, because if the animal required this vitamin, the hamster might be a useful animal for vitamin C studies since it reproduces and matures so rapidly, and is susceptible to many infections not easily produced in other animals. Since we started this study, Routh and Houchin[1] have concluded that thiamin, riboflavin, pyridoxin, pantothenic acid and nicotinic acid are essential in the diet of the hamster, while Cooper, Waisman and Elvehjem[2] have concluded that biotin and possibly inositol and *p*-aminobenzoic acid, in addition to thiamin, riboflavin, pantothenic acid, pyridoxin, and choline, are essential to the hamster, but that nicotinic acid and ascorbic acid are not. Since no growth curves have been published, we think the present study would be of interest.

The experiments were limited to the single substance ascorbic acid, using a diet containing adequate amounts of other growth essentials.

Procedure: Twenty male hamsters 3–5 weeks old were obtained from a commercial dealer (Henry Bergman, Springfield, Missouri). They were divided into two groups of ten each and of equal weight distribution, average body weight 42 gm., and fed *ad libitum* on a diet with and without added ascorbic acid. The diet was of the following composition:

Dextrose (corn sugar)	50
Casein (vitamin-free)	20
Dried brewer's yeast	10
U.S.P. 11 salt mixture	2
Cod liver oil	2
Corn oil (Mazola)	9
Lard	7
	100



GROWTH-RATES OF MALE HAMSTERS WITH AND WITHOUT DIETARY ASCORBIC ACID.

The diet was made in one kilogram lots at a time, and divided into halves. To one half (500 gm.) was added 3·5 gm. of ascorbic acid. The diet was stored under refrigeration and was analysed for ascorbic acid periodically. At no time did the ascorbic acid content of the diet drop below 4 mgm. per gm. The diet was offered in small porcelain feeders (the "Fisher feeder"). One group was fed the diet plus ascorbic acid, and the other group was fed the plain diet. The food intake and animals were weighed daily for the first week and then every other day until the termination of the experiment. The ten animals of each group were caged together.

Results and conclusions: The accompanying graph shows the average growth-curves of the twenty male hamsters on the diet with and without ascorbic acid. The food intake averaged 3·5 gm. per animal per day after the first thirty days of the experiment, making the ascorbic acid intake of the ascorbic group at least 14·0 mgm. per animal per day. There was no appreciable difference in the growth-curves, health and appearance of the two groups. The average weight increase for the first thirty days was 1·07 gm. per day, as compared with 1·05 gm. per day quoted by Cooper *et al.*[2] for hamsters on a synthetic diet. From this it was concluded that the hamster does not require the addition of ascorbic acid to its diet. Others[1,3] have made the same observation, but no growth-curves were presented.

The investigation was supported in part by a grant from the Graduate School of the University of Minnesota. We wish to express our thanks to Marion B. Clausen for her assistance in caring for the animals, and Mr. John Kaster, who determined the ascorbic acid content of the diets.

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July 12.

[1] Routh, J. I., and Houchin, O. Boyd, *Fed. Proc.*, **1**, 191 (1942).
[2] Cooper, J. H., Waisman, H. A., and Elvehjem, C. A., *Proc. Soc. Exp. Biol. and Med.*, **52**, 250 (1943).
[3] Routh, J. I., personal communication, supplementing ref. 1.

A Dimastigamœba in the Bed of the Dead Sea

PROFILES of mud samples taken from different places and depth in the Dead Sea were inoculated into enrichment cultures prepared in Detmer media, 1 : 2, containing different salt concentrations : 0, ¼, 1, 3, 6, 9, 12, 15, 18, 25, 75 per cent Dead Sea water and also in Dead Sea water. All the cultures were exposed to electric light ; temperature, 25–30° C.

Fig. 1. DIMASTIGAMŒBA OF DIFFERENT SHAPE AND SIZE FROM AN ENRICHMENT CULTURE INOCULATED WITH MUD SAMPLES TAKEN AT A DEPTH OF 330 M. UNSTAINED PREPARATION. × 360.

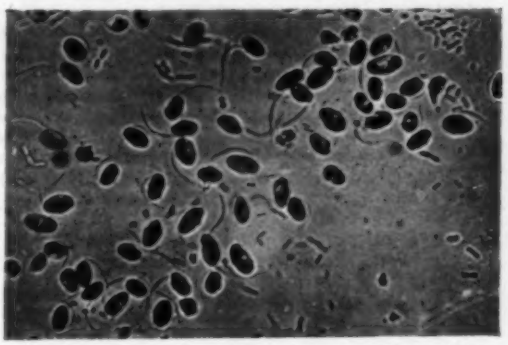

Fig. 2. GREEN FLAGELLATES WITH A SINGLE FLAGELLUM ARISING FROM THE SIDE OF THE CELL. UNSTAINED PREPARATION. × 800.

Rich growth of blue-green algæ was seen in the different salt concentrations. In most of the mud samples the phytoflagellate *Dunaliella viridis* Teod., previously described[1,2], was found. In addition, a very similar green flagellate with a pink eye spot at the posterior end was isolated from a mud sample taken from a depth of 315 m.

In four of the enrichment cultures containing 9, 12, 15, 18 per cent salt, and inoculated with a mud sample from a depth of 330 m. (s.g.1·222 ; temperature, 17·5° C., total salt, 31·6 gm. per 100 c.c.), rich growth of amœbæ and cysts were observed after 2½–3 months.

The amœba (Fig. 1) lives in association with a green flagellate and a blue-green algæ. The small green flagellate (Fig. 2)—2–3μ × 4–6·5μ—has a single flagella arising from the side of the cell and a small pink eye spot. The organism is very actively motile with the flagella in its back. The blue-green alga appears in single cells, pairs or short chains, and probably belongs to the genus Aphanocapsa.

The amœbæ vary much in size from 7–54μ by 17–80μ. They are fairly actively motile.

The amœba readily grows in the light in Detmer media, 1 : 2, containing 15 per cent salt plus 15 per cent Dead Sea mud plus 0·02 per cent peptone. Its main food is the green flagellates and the blue-green algæ ; cannibalism is rather common.

It was possible to grow the amœbæ in the dark in a semi-solid medium (2 parts agar 3 per cent plus 8 parts liquid media) containing Detmer 1 : 2—15 per cent salt, 0·02 per cent peptone, and a very small

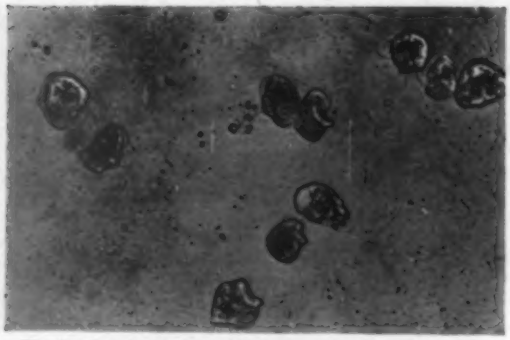

Fig. 3. A FLAGELLATE STAGE OF THE DIMASTIGAMŒBA. UNSTAINED PREPARATION. × 360.

amount of rice starch which was added before inoculation; temperature, 30° C.

The optimum salt concentration is 15–18 per cent. However, the amœbæ survive in saturated solution; they multiply slowly in 6 per cent salt.

The characteristic feature of the amœba is its ability to develop flagella under still undetermined conditions and to behave as a flagellate. The flagellates are round or slightly oval (11–25μ × 16–27μ), having a cytostome and two, four, six or rarely eight flagella (Fig. 3). They are very actively motile.

Full details will be published elsewhere.

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May 14.

[1] Elazari-Volcani, B. (Wilkansky), NATURE, 138, 467 (1936).
[2] Elazari-Volcani, B., "Studies on the Microflora of the Dead Sea" (Jerusalem, 1940).

Numerical Fourier Analysis to Twenty-Nine Harmonics

THIS method uses material developed and made available by C. A. Beevers and H. Lipson[1] for computing Fourier syntheses, which has been found to be readily adaptable to the inverse process of analysis. It is applicable to the analysis of periodic functions in which the amplitudes of harmonic components of thirtieth and higher order are negligible. It gives resolution up to the twenty-ninth harmonic and amplitudes accurate to 1 per cent of the largest component.

The harmonic function $y(x)$ having period l may be written

$$y(x) = A_0 + \sum_n A_n \cos 2\pi n \frac{x}{l} + \sum_n B_n \sin 2\pi n \frac{x}{l},$$

in which the cosine series includes terms up to the thirtieth, the last being of negligible amplitude, and the sine series includes terms up to the twenty-ninth. This form of expression, and the number of constants included, is dictated by the method of analysis; all quantities determinable by the method have been introduced into the equation. The problem of analysing the given function $y(x)$ resolves itself into the determination of the sixty quantities A_0 and all A_n and B_n.

By the method of Bessel[2], these sixty quantities may be determined when the values assumed by $y(x)$ are known (say to 1 per cent of the largest ordinate) for sixty values of x taken at successive intervals of a sixtieth of a period. Let the values of x be denoted by $\frac{ml}{60}$, where m assumes in succession all integral values in the range $0 \leqslant m \leqslant 59$, and let the known corresponding values of $y(x)$ be denoted by y_m. Bessel's solution is

$$A_0 = \tfrac{1}{60} \sum_{m=0}^{59} y_m,$$

$$A_n = \tfrac{1}{30} \sum_{m=0}^{59} y_m \cos 2\pi \frac{nm}{60}, \quad 1 \leqslant n \leqslant 29,$$

$$A_{30} = \tfrac{1}{60} \sum_{m=0}^{59} y_m \cos 2\pi \frac{30m}{60},$$

$$B_n = \tfrac{1}{30} \sum_{m=0}^{59} y_m \sin 2\pi \frac{nm}{60}.$$

Here A_0 may be written for purposes of computation as

$$A_0 = \tfrac{1}{60} \sum_{m=0}^{59} y_m \cos 2\pi \frac{nm}{60}, \quad n = 0.$$

The quantities to be determined are summations of sixty terms, each of the form $C_m \begin{matrix}\sin \\ \cos\end{matrix} 2\pi \frac{nm}{60}$, where n and m are integers such that $0 \leqslant n \leqslant 30$ and $0 \leqslant m \leqslant 59$.

The functions $C_m \begin{matrix}\sin \\ \cos\end{matrix} 2\pi \frac{nm}{60}$ are the functions tabulated by Beevers and Lipson on their sine and cosine strips. Their values are given to the nearest integer for all values of C_m from 1 to 99. The argument $2\pi \frac{nm}{60}$ is symmetrical with respect to n and m; tabulated values of the functions are given for ranges of 0 to 15 for one integer and of 0 to 20 for the other. To use the strips for the purpose of analysis, each strip may be taken as a row of entries for given C_m and m for all values of n from 0 to 15. Since the functions $\begin{matrix}\sin \\ \cos\end{matrix} 2\pi \frac{nm}{60}$ are either symmetrical or anti-symmetrical about the value $n = 15$ according as the functions are non-zero or zero for this value, the extension of the functions to $n = 30$ can be mechanically carried out at a convenient stage in the calculations.

The symmetries of $\begin{matrix}\sin \\ \cos\end{matrix} 2\pi \frac{nm}{60}$ about the values $m = 30$ and $m = 15$ may be applied to reduce the m-summations from 60-term summations to summations of 14, 15 or 16 terms taken over the first quarter period of $\begin{matrix}\sin \\ \cos\end{matrix} 2\pi \frac{nm}{60}$. The symmetries are as shown in the accompanying table.

Group \ m =	30	15	Amplitude notation for quarter period summations
$\cos 2\pi \frac{nm}{60}$, n even	symmetrical	symmetrical	d_0 to d_{15}
,, n odd	symmetrical	anti-symmetrical	e_0 to e_{15}
$\sin 2\pi \frac{nm}{60}$, n even	anti-symmetrical	anti-symmetrical	f_1 to f_{15}
,, n odd	anti-symmetrical	symmetrical	g_1 to g_{15}

Thus

$$(n \text{ even}) \quad \sum_{m=0}^{29} y_m \cos 2\pi \frac{nm}{60} = \sum_{m=0}^{15} d_m \cos 2\pi \frac{nm}{60}$$

$$(n \text{ odd}) \quad \sum_{m=0}^{29} y_m \cos 2\pi \frac{nm}{60} = \sum_{m=0}^{14} e_m \cos 2\pi \frac{nm}{60}$$

$$(n \text{ even}) \quad \sum_{m=0}^{29} y_m \sin 2\pi \frac{nm}{60} = \sum_{m=1}^{14} f_m \sin 2\pi \frac{nm}{60}$$

$$(n \text{ odd}) \quad \sum_{m=0}^{29} y_m \sin 2\pi \frac{nm}{60} = \sum_{m=1}^{15} g_m \sin 2\pi \frac{nm}{60}$$

The procedure is now as follows. Select from the box of strips the fourteen, fifteen or sixteen strips required for one group of summations. Separate these into two sets according as the value given on the strip for $n = 15$ is zero or non-zero and arrange the two sets separately for addition of the columns of constant n. If an n-even group is being worked, total the columns for $n = 0, 2, 4 \ldots$ in both sets; if an n-odd group is being worked, total the columns for $n = 1, 3, 5 \ldots$ in both sets. The totals for the two sets must be added according to columns to give the summations up to the fifteenth order of n. The totals for the two sets must be subtracted to give the higher orders of n in descending order, the anti-symmetric set being subtracted from the symmetric set.

The following simple checks are applicable (subsidiary checking is desirable for amplitude calculations and strip selection):

$$\sum_{n=0}^{30} A_n = y_0;$$

$$\sum_{n=1}^{29} B_n \sin 6n^\circ = \tfrac{1}{2}(y_1 - y_{29});$$

$$\sum_{\substack{n=0 \\ n \text{ even}}}^{30} (-1)^{n/2} A_n + \sum_{\substack{n=1 \\ n \text{ odd}}}^{29} (-1)^{(n-1)/2} B_n = y_{15}.$$

The whole process of computing and checking can be carried through for twenty-nine harmonics in less than two hours. The method has proved satisfactory in regular use and has been found less tiring than the process of curve tracing necessary in machine analysis. Except for convenience in checking, no more harmonics need be determined than are actually required. The procedure can be quickly learnt, errors are not liable to occur, and the calculations, including checking, can be performed almost entirely on an adding machine.

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[1] *Proc. Phys. Soc.*, **48**, 772 (1936). NATURE, **137**, 825 (1936).
[2] Whittaker and Robinson, "Calculus of Observations", pp. 264 *et seq.*

Miss Ross has done a useful service in directing attention to the value of the Beevers-Lipson strips for the process of Fourier analysis. These strips were originally designed for Fourier synthesis in crystal-structure determination, and for this purpose printed copies have been supplied to some forty crystal-structure laboratories (a few copies of the uncut tables are still available from this address). It seems likely, however, that the application to Fourier analysis is of rather wider interest. Prof. Max Born suggested this use of the strips to us some years ago, but it was only after inquiries by other workers, and finally by hearing of the successful work of Miss Ross, that we have come to realize that the strips provide by far the most convenient practical method of Fourier analysis available in an ordinary laboratory.

The Fourier machine which we have recently described[1] will perform the same work as the strips, and would therefore carry out the process described by Miss Ross. It would enable the user to go from the numerical values of the y_m to the twenty-nine Fourier coefficients in a time of less than eight minutes. Even faster working would be permitted by a minor extension of the machine so as to attain a wave-number of 30 instead of 24 as at present, and a machine working with similar components but with thirty-one counters and going up to a wave-number of 60 would enable the operator to complete the whole process in about three minutes. There may be applications of Fourier analysis where this extreme speed is desirable. Checking could be readily carried out by re-synthesis of the function.

The process can be done, of course, on a commercial scale by the use of the Hollerith series of tabulating machines, but these are considerably slower than the Beevers machine, although they provide a flexible and reliable method.

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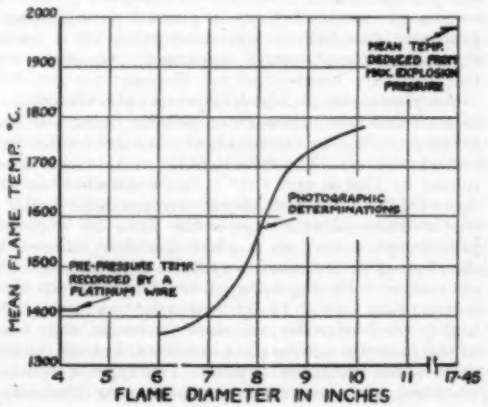
[1] Beevers, *Proc. Phys. Soc.*, **51**, 660 (1939). Macewan and Beevers, *J. Sci. Instr.*, **19**, 150 (1942).

Temperature Gradients in Gaseous Explosions

A NEW method of determining flame temperatures during explosions in a closed vessel has been evolved. Briefly, the method consists of recording photographically flame travel and simultaneously, by means of a very sensitive diaphragm type of pressure indicator, the pressure rise in a large spherical explosion vessel 17·45 in. in diameter with central



ignition. By correlating flame diameter with pressure rise the mean gas temperature in the burnt portion could be deduced at different instants during the explosion (up to a limiting diameter of 10 in.).

The results obtained with a 10 per cent oxygen plus 90 per cent carbon monoxide mixture are shown in the accompanying graph. Also indicated is the pre-pressure flame temperature measured by means of a platinum resistance thermometer (which in the case of very over-rich mixtures registers the same temperature as a quartz-coated platinum resistance thermometer[1]) and the maximum mean gas temperature obtained from the maximum explosion pressure[2].

It will be noted that the mean temperature rises from a value very much in line with the platinum wire temperature at a diameter of 6 in. up to a value, at 10 in. diameter, approaching the mean temperature inferred from the maximum pressure. This shows that the latent energy[3] in the flame gases diminishes as the flame travels outwards from the spark.

Direct experimental confirmation of David's postulate[4] that the latent energy diminishes with distance of flame travel from the igniting source is thus furnished by the experiment.

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Aug. 11.

[1] David, Leah and Pugh, *Phil. Mag.*, (7), **31**, 156 (1941).

[2] David and Leah, *Phil. Mag.*, (7), **28**, 513 (1936).

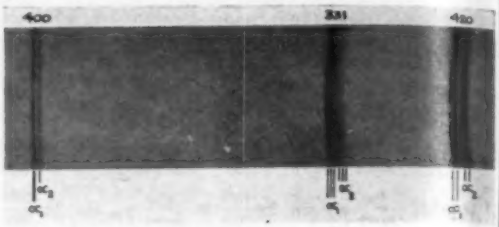
[3] David, "The Abnormality of Flame Gases", *Proc. Inst. Mech. Eng.* (in the press).

[4] *Phil. Mag.*, (7), **23**, 345 (1937).

Structure of Nickel Oxide

THE development of modern X-ray powder photographic methods has opened up new possibilities for the examination of the fine structure of crystalline substances. The high resolution and definition of the reflexions, particularly in the high-order lines, which is obtainable with such circular cameras as that described by Bradley, Lipson and Petch[1], has not only meant an increase in accuracy of lattice parameter measurements, but has also enabled interesting phenomena in alloys to be observed[2]. The detection of extra reflexions in powder photographs of graphite[3] has led to the description of a second crystalline form[4], which apparently co-exists with the structure established by Bernal.

Another instance, which depends upon the observation of the fine structure of powder lines, has been noticed during an examination of nickel oxides from various sources. The structure for nickel oxide determined by Cairns and Ott[5] is face-centred cubic with $a_0 = 4{\cdot}1684$ kX., the atomic arrangement being of the sodium chloride type; the lines on a powder photograph taken on a small-diameter camera are distributed in the usual way for a face-centred cubic substance. Photographs of well-crystallized specimens taken on a 19-cm. diameter camera giving highly resolved reflexions show, however, that many of the lines are not simple α-doublets, but are doubled or in some instances tripled. The type of reflexion obtained is shown in the accompanying illustration,



PART OF X-RAY POWDER PHOTOGRAPH (CALCIUM $K\alpha$-RADIATION, 19 CM. CAMERA) OF NICKEL OXIDE. × 2.

which is a reproduction of the high-order end of the pattern with cobalt $K\alpha$-radiation.

Photographs taken with various radiations, to enable a sufficient number of (hkl) reflexions to be analysed, indicate that all lines are doubled or have more than one α-doublet component except those with indices ($h00$).

If the structure of nickel oxide departs very slightly from cubic symmetry in a manner that makes it rhombohedral, the observed modifications of the reflexions can be explained. The distortion is so small that it is difficult to ascertain with complete certainty whether the angle of the unit rhomb is greater or less than the theoretical for cubic symmetry, but a larger value seems most probable when the intensities and separations of the components of all the observable reflexions are taken into account. On this assumption the most probable values for the lattice parameters of the rhombohedral unit cell are, at 20° C., $a_0 = 2{\cdot}9459$ kX., $\alpha = 60°\ 4{\cdot}2'$.

The effect has been observed for nickel oxides of widely different origins, including a variety commonly known as 'black nickel oxide', and is noticeable with feebly crystallized specimens in spite of some broadening of the reflexions owing to small crystal size. It is not obtained with monoxides of the other transition elements iron and cobalt, and indeed the solution of relatively small percentages of these oxides in nickel oxide causes a reduction in separation of the components of the complex reflexions. The asymmetry of the structural unit of nickel oxide may therefore be associated with the slightly smaller effective size of the nickel atom as compared with iron and cobalt; the atomic packing is affected in such a way that there is the equivalent of a small compression of the cubic lattice along a triad axis.

There may well be other crystals, that to a first approximation appear to conform to the isometric system, but would in fact on precision examination be found to possess a less simple structure. Latest refinements in powder photographic technique which permit the fine structure of the reflexion lines to be studied may yield interesting results in this connexion.

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Aug. 3.

[1] Bradley, A. J., Lipson H. and Petch, N. J., *J. Sci. Instr.*, **18**, 216 (1941).

[2] Bradley, A. J., *Proc. Phys. Soc.*, **52**, 80 (1940).

[3] Taylor, A., and Laidler, D., NATURE, **146**, 130 (1940).

[4] Lipson, H., and Stokes, A. R., *Proc. Roy. Soc.*, A, **181**, 101 (1942).

[5] Cairns, R. W., and Ott, E., *J. Amer. Chem. Soc.*, **55**, 527 (1933).

SOME EFFECTS ON LIESEGANG RINGS

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THE observations described below were made in the course of investigations carried out under the auspices of the Sunfield Agricultural Centre, Clent (now the Agricultural Centre, Blairs, Aberdeen), on the sensitivity of Liesegang rings to various influences, undertaken with the view of applying them to certain biological problems.

Formative Catalysis

Liesegang[1] uses the term *Formcatalysator* for potassium dichromate when, through a double reaction, it brings about rings of silver chloride not formed without its presence.

We observed two cases of formative catalysis causing stratification of manganese sulphide. When ammonium sulphide solution is allowed to diffuse into gelatine containing manganese chloride in a test-tube, the latter is deposited almost homogeneously. If small amounts of stannous chloride or copper sulphate are added to the manganese chloride–gelatine, distinct layers separated by completely clear spaces are formed. In the case of stannous chloride the layers begin 8–25 mm. below the surface of the gelatine and continue to be formed throughout the length of the test-tube. Their thickness and the distance between them increase in a regular way similar to the silver chromate layers. The minimal concentration of stannous chloride producing the effect is 10^{-6}, the concentration of the manganese chloride being 10^{-3} and that of the ammonium sulphide 1–2 per cent. Higher concentrations of stannous chloride produce more and thinner layers. The manganese sulphide layers due to the action of copper sulphate begin farther down the tube where diffusion is rather slow. The minimal concentration of copper sulphate still active is 10^{-4} (manganese chloride 10^{-3}, ammonium sulphide 1–2 per cent). In both cases the concentration of the formative catalyst must be increased if higher concentrations of manganese chloride and ammonium sulphide are used.

This effect cannot be explained by a double reaction as in Liesegang's experiment. Stannous chloride and copper sulphate alone form no layers with ammonium sulphide, and the necessary quantities are very small—2·5 γ $Cu^{\cdot\cdot}$ in 10 ml. gelatine, which is of the order of the Feigl spot-test limits.

Of other metal salts, sodium arsenite and chromium sulphate show a similar effect with manganese sulphide, but much weaker than $Cu^{\cdot\cdot}$ and $Sn^{\cdot\cdot}$; $Fe^{\cdot\cdot\cdot}$, $Pb^{\cdot\cdot}$, $Ni^{\cdot\cdot}$, $Co^{\cdot\cdot}$, $Ba^{\cdot\cdot}$, $Mg^{\cdot\cdot}$, $Hg^{\cdot\cdot}$, $Hg^{\cdot}$, $Ag^{\cdot}$, $Zn^{\cdot\cdot}$, $Cd^{\cdot\cdot}$ are inactive.

We observed also a case of negative formative catalysis: lead salts interfere with or prevent the formation of silver chromate layers when added to silver nitrate–gelatine into which potassium dichromate is diffusing. The effect is noticeable with a lead salt concentration of 10^{-5} and stratification is completely prevented at 10^{-4} (silver nitrate 0·5 per cent, potassium chromate 5 per cent). Sodium arsenite at concentration 10^{-4} also prevents formation of silver chromate layers, whereas $Cu^{\cdot\cdot}$, $Sn^{\cdot\cdot\cdot\cdot}$, $Cr^{\cdot\cdot\cdot}$, $Mn^{\cdot\cdot}$, $Zn^{\cdot\cdot}$, $Cd^{\cdot\cdot}$, $Ca^{\cdot\cdot}$, all at concentration 10^{-4}, have no effect. $Fe^{\cdot\cdot\cdot}$ and $Hg^{\cdot\cdot}$ cause a slight disturbance. A similar effect of lead salts at concentration 10^{-4} could be observed in the case of manganese hydroxide layers (8 per cent ammonia diffusing into gelatine containing 0·5 per cent manganese chloride). Here, too, other metals are far less active ($Cu^{\cdot\cdot}$, $AsO_3^{\prime\prime\prime}$, $Sn^{\cdot\cdot}$) or inactive ($Ag^{\cdot}$, $Hg^{\cdot}$, $Hg^{\cdot\cdot}$, $Zn^{\cdot\cdot}$, $Cd^{\cdot\cdot}$, $Sn^{\cdot\cdot\cdot\cdot}$, $Cr^{\cdot\cdot\cdot}$, $Ba^{\cdot\cdot}$, $Mg^{\cdot\cdot}$). Other influences, acidity, alkalinity, oxidizing and reducing agents require a higher concentration in order to interfere with the manganese hydroxide layers.

Effects of Mercury Vapour

When a piece of metal sheet (zinc, iron, tin, lead or copper), either superficially amalgamated by spreading mercury on its surface or treated with mercuric chloride solution, is placed 3–5 mm. above a glass plate bearing a layer of 5 per cent gelatine containing 0·1 per cent potassium dichromate in the centre of which a drop of 50 per cent silver nitrate solution has been placed, the silver chromate rings are affected. The plate should be covered and left for 20–30 hours. Three different effects can be observed:

(1) Serious disturbance of the rings, the silver chromate being partly deposited homogeneously or in irregular patches. This effect has been described by Shemyakin[2]. (2) Intensification of the micro-rings. (3) Formation of a new structure on the surface of the gelatine. It consists of straight lines proceeding in a radial direction strictly perpendicular to the micro-rings. There are about 100–150 of them to the millimetre and they can be clearly seen under the microscope. The optical effect is visible to the naked eye as soon as the plate is uncovered after the experiment. Acting as a diffraction grating, a bright spectrum is produced in reflected as well as in transmitted light. Exposure of the plate to mercury vapour for a short period shows that the formation of these radial lines takes place only at the periphery of the expanding diffusion circle. Besides the radial lines, wrinkles are also produced on the gelatine surface. The phenomenon is not of a stable nature and the radial lines get very faint some days after the experiment.

So far the effect has been observed only under the influence of mercury. Lead, iron, tin, zinc, copper, nickel do not produce it. This seems to indicate that it is due to action of the vapour and not to a radiation as suggested by Shemyakin[2].

Effects of Temperature, *p*H, and Light

The structures formed by diffusion of silver nitrate into potassium dichromate–gelatine are influenced by temperature, *p*H and light. In all three cases the effects on the layers are opposite to those on the micro-rings. The concentrations used for these experiments were: 5 per cent gelatine containing 0·1 per cent potassium dichromate; 8·5 per cent silver nitrate as diffusing solution.

Effects on the layers. Increasing temperature promotes layer formation. Whereas only a few layers appear at temperatures between 0° and 10°, a complete series from the gelatine surface down the tube is obtained above 15°.

Alkalinity promotes layer formation at low temperature (0°–10°), where a complete series can be obtained by adding 0·02 per cent sodium hydroxide to the gelatine. Higher alkalinity (0·04 per cent sodium hydroxide) brings about continuous precipitation, but above 0·05–0·06 per cent sodium hydroxide layers are again formed up to 0·3 per cent. Above that concentration continuous precipitation again takes place. Acidity shortens the range of the layers with increasing concentration, leaving only the

top ones, and layer formation is prevented altogether above 0·15–0·2 per cent sulphuric acid.

Light at temperatures below 10° slightly reduces the number of layers. At higher temperature no such effect takes place.

Effects on the micro-rings. The formation of micro-rings is disturbed and eventually prevented with increasing temperature. Alkalinity also has a disturbing influence and above 0·04 per cent sodium hydroxide no micro-rings are formed. Acidity promotes the formation of micro-rings, the optimal concentration being 0·02–0·12 per cent sulphuric acid. At higher concentrations their range is reduced and above 0·3 per cent sulphuric acid none is formed.

The most striking influence on the micro-rings is that of light. It is strongly positive and seems to be almost indispensable for their formation. This, however, could not be definitely established; as a few micro-rings near the gelatine surface have been observed in some experiments conducted in the dark even if the chromate gelatine had been prepared in the red light of a photographic developing lamp. But it is certain that at room temperature, with the concentrations mentioned, no micro-rings are formed more than 20 mm. from the gelatine surface without the action of light. If such an experiment, after having proceeded in the dark for at least twenty-four hours, is exposed to strong light for a limited time, micro-rings are formed beginning from the level to which diffusion has gone. Their formation does not cease when the light is removed but continues in the dark for a period the length of which depends on the intensity of the light and the duration of the exposure.

A chromate gelatine containing 5 per cent gelatine, 0·1 per cent potassium dichromate and 0·03 per cent sulphuric acid was prepared in red light and poured into test-tubes which were kept in the dark. On the following day, 8·5 per cent silver nitrate solution was poured on top of the set gelatine. After thirty hours the tubes were exposed to various kinds of light with the following results:

Light source	Time of exposure	Width of belt of micro-rings	Approx. time of micro-ring formation
150-watt bulb at 50 cm. dist.	2 hr.	No micro-rings	—
Daylight	20 min.	No micro-rings	—
Daylight	40 min.	2 mm.	3–4 hr.
Daylight	60 min.	3 mm.	5–6 hr.
Quartz lamp at 25 cm. dist.	7 min.	2 mm.	3–4 hr.
Quartz lamp at 25 cm. dist.	17 min.	20 mm.	2 days

This after-effect of light can be explained by a photochemical change of the chromate gelatine by which conditions for the formation of micro-rings are produced, and which is slowly reversed in the dark. The change itself also seems to take some time if the light is not very strong. In the case of daylight, not with the quartz-lamp, the micro-rings did not appear immediately upon exposure but 1–2 mm. farther down.

We wish to express thanks to the members of the service scheme of the Agricultural Centre, Heathcot House, Blairs, Aberdeen, for their financial help, which has enabled us to carry out the present work.

[1] Liesegang, *Koll. Z.*, **31**, 1 (1937). "Chemische Reaktionen in Gallerten" (Steinkopff, 1924).

[2] Shemyakin and Michaev, *Amer. Chem. Abs.*, 3662 (1940).

SCIENCE UNDER FASCISM AND DEMOCRACY

AT a Conference organized by the Association of Scientific Workers (West Midland Area) in Birmingham, on August 22, scientific workers from nine nations contrasted the position of science, and scientific workers, in countries under fascist and democratic regimes.

The chairman, Dr. W. Wilson, emphasized that the war effort of the United Nations had depended to a very high degree upon the work of men of science, and if the prosperity and health of the world was to be ensured after the War then the role of the man of science would be no less important. Science, however, can only be expected to flourish in a social and political atmosphere which allows freedom of thought. The Lord Mayor of Birmingham (Councillor W. S. Lewis) tendered a civic welcome to the assembled delegates, and expressed the hope that it would be speedily possible to re-establish the scientific life and culture of the occupied countries in Europe which the Nazis are now trying to destroy.

In a message to the conference, Prof. Semon Sarkisov said that the German invaders had already felt the strength of Soviet science in the blows struck by the Red Army. Thanks to their peace-time achievements, and intensive war-time activity, the men of science had enabled the resources of the Urals, Siberia, and Kazakhstan to be put into effective use for the country's war effort. In the sphere of agriculture they had been able to move successfully a number of essential crops from the Ukraine to the eastern regions of the U.S.S.R. Dr. Goebbels had said: "Humanism, culture, and international law are empty words for us". Was it, then, a wonder that German medical science, for example, had not produced anything new for the benefit of mankind during the period of Nazi rule, but on the contrary it had rapidly declined? Hatred of mankind was the basic feature of fascism, which aimed at enslaving the peoples of the world by using a pseudo-scientific ideology based on the would-be superiority of the German race.

A. van Anrooy (Holland) gave an account of the historical growth of science in Holland under the liberal regimes of the seventeenth and eighteenth centuries, this leading to many famous medieval inventions. The Universities of Leyden and Delft had become famous throughout the world, but under the rule of Seiss Inquart they have been closed and the student organizations disbanded. Dr. C. Koeck, speaking for Austria, outlined the disastrous results upon the scientific life of Vienna of the occupation by the Nazis, since science is merely of secondary importance under fascism.

Prof. J. H. Hildebrand (United States) gave personal impressions of German science gained during visits paid to Germany under the regimes of the Kaiser, Republic, and the Nazis, and instanced many scientific absurdities perpetrated by "Aryan scientists". A totalitarian regime cannot permit any challenge to its power, and the freedom to seek and speak the truth is a danger against which it must always be suspicious. Benevolent, enlightened despots have been very few. Men of science must add a fifth freedom to their charter: "the freedom to exercise unquenchable curiosity". They must not be bribed by any false promises of political Messiahs who might interfere with their freedom to seek the truth; they

must insist upon asking questions and getting their answers from Nature rather than from a Dr. Goebbels.

Dr. B. Schober (Czechoslovakia) gave details of the destruction of Czechoslovak scientific culture since Nazi occupation, and the persecution of the students and professors following their resistance to fascist domination. The health of the nation is deteriorating rapidly since the food supplies available provide only one- to two-thirds of the essential calories. Mr. P. M. Yap contrasted the scientific spirit in China and Japan, showing that the Japanese treatment of science follows very closely that of Germany. Full scientific progress in China has been retarded in the past by its dependence upon political and social conditions, but at present these are highly favourable and science is receiving the support of both Government and people. Mr. J. J. Ducenne dealt with the general position of science in Belgium before the War, and then gave impressions of the struggle between men of science and the occupying Nazis.

Prof. J. B. S. Haldane paid a tribute to the scientific workers who had been able to escape from occupied countries and were giving us inestimable help in our destruction of fascism. He then dealt with science in the U.S.S.R., stating that the system of planning had enabled the country to mobilize all men of science for the war effort much more quickly than we could. Planning was done largely by men of science in the U.S.S.R., and it was important to realize that the present power of the Red Army was due to scientific planning in the past, particularly in geological research, which employs some two thousand trained geologists. He thought that undoubtedly the Soviet Union had something to learn from Great Britain regarding liberty; similarly we might learn a lot from the Soviets about planning. It was all-important that we should learn how to combine planning and freedom, for that was the key problem of the future. It must be realized that scientific workers are skilled manual workers, and we must resist any attempt by educationists to make a gap between the two. The utmost scientific knowledge must be given to ordinary people.

Dr. G. Fournier (France) showed that it was impossible for the man of science to live remote from politics and the affairs of the world. Too many men of science had said: "I am not interested in politics". Now the politicians have become too interested in the men of science, and as a result many had found themselves in custody, and their books burnt. Science has a social value and the man of science cannot wash his hands of his discoveries. It is his duty to see that they are used for the betterment of mankind, and not for its destruction. In future he must be continuously alert to ensure that fascism does not reappear under some other name elsewhere in the world.

Dr. J. G. Siebert (Germany) summed up the discussion, and by resolution the meeting sent its greetings to peoples in subjected countries, and expressed the view that, as rational organization of science for the purpose of waging war would bring victory over the Axis powers, a thorough co-ordination of scientific and technical enterprise could forge weapons to destroy the evils of want, disease, and ignorance which would still have to be confronted when the War was won. The meeting pledged fullest support for "the impending large-scale decisive invasion of the European continent. We call on all scientists and technicians to give of their utmost, whether in workshop or in hospital, in laboratory or at the battlefront".

J. S. CLIFF.

CIVILIAN CONTRIBUTION TO EDUCATION IN THE FORCES

THE Report of the Central Advisory Council for Education in H.M. Forces for the period October 1942–March 1943 again directs attention to the remarkable way in which the project is growing. Much of the increase in demand can be explained by the introduction of compulsory educational periods in the Army during training hours for the months November–February. This not only increased the desire for supplementary lectures by experienced civilians but has, principally in Anti-Aircraft Command, called for aid from the university and university college regional committees in giving the suggested talks on citizenship in a number of small units which do not possess suitable teachers within their ranks. Steps taken by the Royal Air Force, and more recently by the Royal Navy, to encourage the study of current affairs, account for an increase in educational activities by these Services proportionately greater than that for the Army.

There has been an increased demand for lectures and classes by many women's units. Efforts have been made to meet this demand by adding lecturers to regional panels who are particularly well equipped to give the personal approach and treatment of subject which is required by audiences of women. At one A.T.S. conference it was revealed that arranging education in women's units is often more difficult than in men's units, but that the A.T.S. could do much more in the way of education if the right subjects and approach could be found. A profitable introduction to citizenship was being made in women's units through their interest in social services.

An interesting development has been the increase in the number of "site visitors". These are men and women who visit small units at regular intervals to guide and advise units on many social and educational matters. Usually the visit takes the form of an informal talk or discussion and is often followed by requests for help or information in regard to all kinds of group or individual activities. The voluntary organizations connected with education have contributed greatly to the success of these site visits.

People who are interested in the development of residential colleges for adult education for the civilian population will find much to interest them in the short schools and conferences which were arranged by the regional committees for H.M. Forces. In the period under review, 126 of these courses, etc., were held, 44 of them being residential. They were attended by 4,398 Service men and women, including members of the U.S. Forces. One of these courses was of three weeks' duration and dealt with the basic elements of responsible citizenship, while other courses of the same nature lasted for shorter periods. The experiences gained during these periods of residential study should be of great value to educationists connected with adult work in the post-war period. It should be pointed out that similar courses were arranged for men and women from the Dominions, the fighting services of other members of the United Nations and the merchant navies of Britain and other countries.

The statistics issued in this report show that the number of single lectures given by civilian lecturers was 61,546, an increase of 44 per cent over the previous six months. The number of short courses increased

by 15 per cent to 3,223, while the number of continuous classes rose to 1,369, an increase of 35 per cent.

Topics of current interest were responsible for much of the increase, while the increase in non-vocational science and psychology (classified separately) was very considerable. Handicrafts again proved popular and increased in number, but the shortage of materials has hindered the formation of classes in a number of crafts.

The growing volume of work undertaken by the regional committees is a tribute not only to all the individuals who take part in the work but also to the Service authorities for their wisdom in encouraging educational activities among serving men and women.

PROPOSALS FOR NEW BASIC PHYSICAL POSTULATES

IN a series of papers published in 1942, some in the *Manual of Myiology*, Dr. H. T. Townsend, of S. Paulo, Brazil, puts forward a revolutionary set of new physical theories. While there does not appear to be adequate evidence for the views put forward in the papers under notice, the following are principal postulates, mainly in the author's own words:

Centrifugal force is inherent in all cosmogen (mass + motion) and is the most basic cosmic force. Gravity is an equally basic cosmic force. Hence the two are one and the same force. Gravity is the complement of bound centrifugal force. It is unbound centrifugal force. Centrifugal force makes up all cosmogen by its interaction with the actinionic medium. Spinning actinions spinning round a vortex centre are the basis and the electron formed from them spins inherently. Spinning atoms are formed from spinning electrons and spinning molecules from spinning atoms. Centrifugal force centres vary from innumerable microfield centres (vortices in the medium) to the single great cosmic field centre, and each maintains its individual electro-magnetodynamic (commonly called magnetic) field. The repulsions between these fields constitute the force of gravity. Electromagnetic radiation is micro-centrifugal fields in wave formation travelling at top speed in the transmitting (actionic) medium.

The number of atomic weight units in the electronic unit is 546, which thus becomes the basic physical constant. All the atomic weights of the chemical elements are multiples of 546. The actinion carries the force quantum of 12×10^{-30} dyne, the equivalent of the motion of 546 actinions constituting a photon. A photon is pure energy acting on the mass of the transmitting actionic medium. The ultimate force quantum is the dynamion, which on coming in contact with an ultimate mass particle or akinesion at once imparts to it an ultimate energy quantum or kinesion, resulting in an actinion. A photon is 546 kinesions, or the result of 546 liberated dynamions imparting 546 motion units to as many actinions.

Applying the 546-multiple key to the light-velocity problem, it is found that the only number within the limited range of Michelson's (1927) experimental results that is a multiple of the square of 546 is 29979737424, which is also within the Henning and Jaeger corrected range of Rosa and Dorsey's (1907) measurements of the electrostatic unit to the electromagnetic unit ratio in our terms of light velocity. It is Michelson's lower to mean record plus the possible retardation by his mirrors.

FORTHCOMING EVENTS

Saturday, September 11

BRITISH FEDERATION OF BUSINESS AND PROFESSIONAL WOMEN (at the Royal Institution, 21 Albemarle Street, Piccadilly, London, W.1), at 3 p.m.—Dr. Margaret Mead: "Science, Women and the Problem of Power".

Saturday, September 18

BRITISH RHEOLOGIST'S CLUB (at Loughborough College, Loughborough), at 10 a.m.—Discussion on "Rheology in the Hosiery, Leather, Shoe and Allied Trades".

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at the Middlesex Hospital, London, W.1), at 2.30 p.m.—Discussion on "Clinical Photography".

Saturday, September 18–Sunday, September 19

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX (at the Royal Society, Burlington House, Piccadilly, London, W.1).—Eighteenth ASLIB Conference.

Saturday, September 18

10.30 a.m.—Annual General Meeting.
11.30 a.m.—Prof. J. D. Bernal, F.R.S.: "Positive Information Service".
2.0 p.m.—Symposium on "The International Rehabilitation of Special Library Services".

Sunday, September 19

10.30 a.m.—Mr. F. C. Francis: "The British Museum as a Special Library".
11.45 a.m.—Major Irving Newman: "The Organisation of American Photographic Information Services in Great Britain".
2.30 p.m.—Symposium on "The Co-ordination of Abstracting".
5.0 p.m.—"ASLIB: What it is Doing and What it Hopes to Do".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT MASTER TO TEACH ENGINEERING DRAWING in the Middlesbrough Technical School for Boys—The Director of Education, Education Offices, Middlesbrough (September 18).

HEAD OF THE DEPARTMENT OF MATHEMATICS—The Principal, Heriot Watt College, Edinburgh (September 20).

HEADS OF THE DEPARTMENTS OF PHYSIOLOGY, MEDICINE, AND SURGERY—The Bursar, Royal Veterinary College and Hospital, at The University, Reading (October 1).

CHAIR OF NAVAL ARCHITECTURE—The Acting Secretary of University Court, The University, Glasgow (October 4).

DIRECTOR OF ROBERT GORDON'S TECHNICAL COLLEGE—The Secretary, Robert Gordon's Technical College, Aberdeen (October 16).

CHIEF CERAMIC RESEARCH CHEMIST—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. O.N.F. 1457X).

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

London School of Hygiene and Tropical Medicine (University of London) incorporating the Ross Institute. Report of a Meeting of the Ross Institute Industrial Advisory Committee on Thursday, 27th May 1943. Pp. 24. (London: London School of Hygiene and Tropical Medicine.) [128

Imperial Agricultural Bureaux. Joint Publication No. 5: The Production of Seed of Root Crops and Vegetables. Pp. 96. (East Malling: Imperial Bureau of Horticulture and Plantation Crops; Aberystwyth: Imperial Bureau of Pastures and Forage Crops; Cambridge: Imperial Bureau of Plant Breeding and Genetics.) 3s. [138

Institute of Welding. Twentieth Annual Report of the Council, Accounts and Balance Sheet to 31 December 1942. Pp. 20. (London: Institute of Welding.) [178

Otto Jespersen: his Work for an International Auxiliary Language. By H. Jacob. Pp. 32. (Loughton: International Language (Ido) Society of Great Britain.) 1s. [188

Other Countries

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 93, 1941. Pp. iii+336. (Philadelphia, Pa.: Academy of Natural Sciences.) 7.50 dollars. [128

Fifty-eighth Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1940–1941. Pp. 13. (Washington, D.C.: Government Printing Office.) [128

Smithsonian Institution: Bureau of American Ethnology. Bulletin 129: An Archaeological Survey of Pickwick Basin in the adjacent portions of the States of Alabama, Mississippi and Tennessee. By William S. Webb and David L. DeJarnette; with Additions by Walter B. Jones, J. P. E. Morrison, Marshall T. Newman and Charles E. Snow and William G. Haag. Pp. xxii+536+316 plates. (Washington, D.C.: Government Printing Office.) 2 dollars. [128